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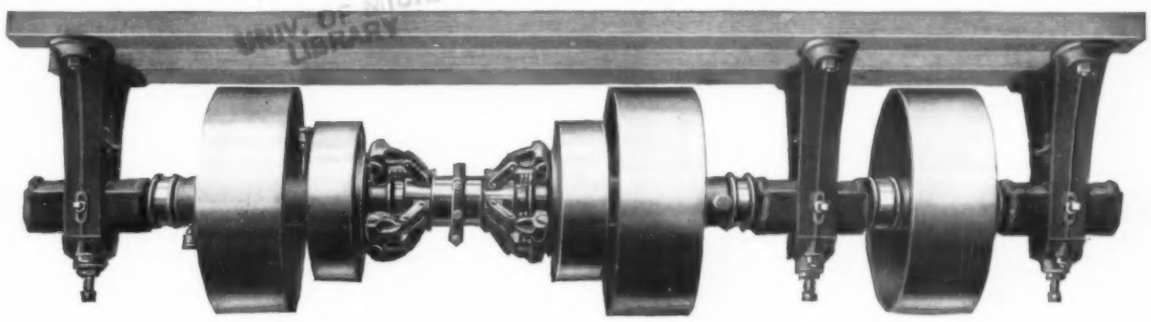

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From Birch Log to Fuse Plug

By John H. Van Deventer

SYNOPSIS—Wood is effectively replacing bronze, steel and other expensive metals as a material for projectile fuse-hole screw plugs. The resulting piece must be accurate, especially in the threads, in order to meet military requirements. This article describes each step in the manufacture of these plugs.

One day not long ago a gentleman came into the editorial rooms of the *American Machinist*, having with him a hardwood fuse plug that had been adopted by a large manufacturer of shells, after meeting the approval of the British military authorities. The fit of this plug when tried in the Canadian shell upon the editor's desk was so much better than that of the former bronze plug, and the evident saving in expense of material and labor was so considerable that it obviously marked an important step toward economy, especially in view of the great number of plugs required. It may not be amiss to describe briefly the function of a fuse-hole plug, since this will help to a better understanding of the importance of the wooden one. Its duty is to protect the threads of the fuse socket and also to close the powder-tube opening while the shell is in transit or storage. On the battlefield, at the gun to be served this protecting plug is removed, and a time fuse or an impact detonator is substituted. Although a large number of these plugs are reclaimed and used again, it is obvious that when shells are made in America and fired in Europe, comparatively few of the plugs come back to their original source; and those that are returned accumulate heavy expense for transportation not only by rail and steamer, but also because of the necessity of carrying them from the battlefield in motor trucks. Also, during these many handlings and reshipments a large number of the plugs become battered so that the threads must be recut before they can be used again—an operation in itself amounting to more than the entire cost of the wooden plug that is used once and then thrown away.

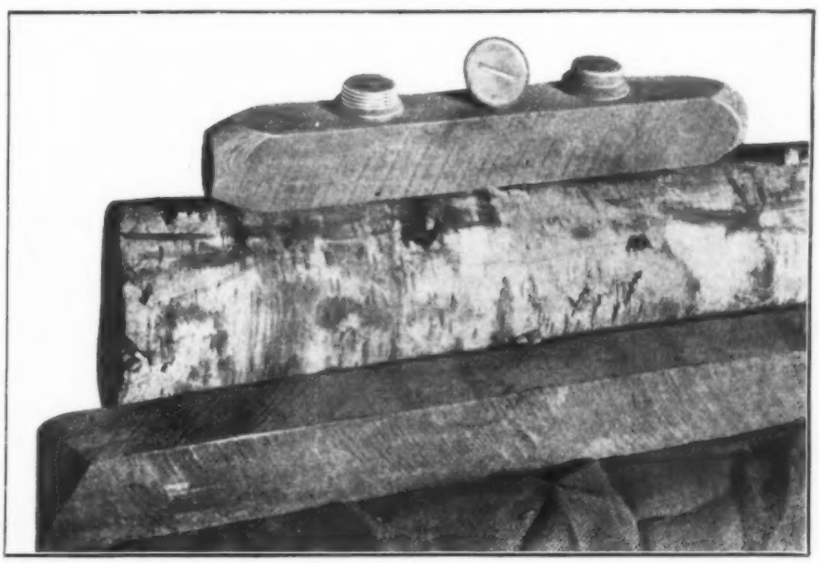


FIG. 1. SIX OPERATIONS TRANSFORM A WHITE BIRCH LOG INTO SHRAPNEL FUSE PLUGS

White birch, yellow birch, beech and maple are ideal materials for plugs of this kind, which must withstand exposure to climatic conditions without changing in size, and upon which accurate threads must be cut. The source of supply is the Berkshire Mountains, in one of the wind-swept valleys of which is a plant owned by the E. B. Estes Co., of New York, N. Y., where these plugs are manufactured. Proximity to the source of raw material is a necessity for a plant that turns these trees into wooden specialties, it being cheaper to take the plant to the trees than to bring the trees to the plant. This company owns its forests and cuts timber in rotation on a plan that brings planting and cutting just 20 years apart. Imagine planning for your pig-iron or bar-steel supply 20 years in advance of the time that you intend to use the material!

To one more familiar with the art of cutting metal than with that of cutting and shaping wood, there is something surprising about quantities, times and speeds in a wood-turning plant. Especially surprising is the length of time that cutting tools will stand up to their work without regrinding or redressing. Even on complicated operations on which four or five cutting, turning and forming tools are combined, a production of 10,000 to 15,000 pieces per day from one machine is nothing out of the ordinary, yet the tools remain untouched for weeks and even months at a time. On automatic turning lathes this daily-production record is far surpassed, the quantity running up to the 50,000 mark for a 10-hr. run on pieces 1½ in. in diameter and 1 in. in length, which are turned, drilled and cut off. Even for small work this is a remarkable production when one considers that these machines do not work on long bar stock, but on short pieces averaging 2 ft. in length. An operator who tends four automatic lathes needs considerable agility to keep the machines supplied with stock, and it is a lucky thing for him that the cutting tools require so little attention.

It should be stated that the process of making fuse-hole plugs covered in this description is not represented as being as highly developed as is possible. Under the conditions calling for quick delivery it was necessary to adapt the work to the machines at hand that were not tied up on other contracts. Thus while turning at present is done on nonautomatic lathes, it is the intention to put this work as soon as possible on automatic machines, which will of course largely increase the production and maintain the necessary accuracy.

Including the felling of the tree, there are seven distinct steps in the process of making wooden fuse-hole plugs. Compare these with the complexity and number of steps necessary in making the bronze plug—the mining of the various ores, their smelting, refining, mixing, remelting into pigs, the molding and casting, the various steps in machining and the numerous transportation of the heavy material. A little thought will give a conception of what the wooden fuse-hole plug means as a simplified economic process aside from any advantages arising from its use.

In this description I will omit the felling of the tree as a part of the process and start with the logs, which range from 6 to 10 in. in diameter. They are ripped into 2⅝-in. square strips, which are then stacked in dry kilns, the usual practice of air seasoning having to be accelerated because of the unforeseen demand for this new product. On the class of work regularly turned out at this plant, strips that come from the ripsaws are not turned until they have seasoned for a year.

The next operation, which prepares the seasoned strip for the turning lathes, is called "sawing and sniping." It consists in cross-sawing the strips into lengths ranging from 20 in. to 24 in. and of "sniping" or coning the ends of these sticks to fit the cone-shaped lathe chucks and the

FIG. 3. THESE OPERATIONS ARE PERFORMED WITH THE DEXTERITY OF A JUGGLER

steadyrests. A view of the apparatus used for this purpose is given in Fig. 3. One operator takes care of both steps in this operation and completes a stick, such as shown at the top of the sniper, in less than 2 sec. He keeps both hands going and tosses the stick end-for-end in the air with the agility of a juggler and a conservation of motion that would cause some of the fathers of efficiency to look over the record of their progeny to see where this child had crept into the family!

Five cutting tools are combined in the fourth operation, in which the sniped stick is turned into plug-blanks at the rate of 8,000 per day for one machine and one operator. The machine used will remind the brass-shop man of a hand screw-machine except that it runs ten times as fast, the work revolving at 3,000 r.p.m. One end of the stick is introduced into the conical chuck threaded upon the inside, which grips by cutting threads upon the conical end of the stick placed within it, thus forming a most secure combined drive and holdback. The other conical end is placed in the steadyrest, or "swing head" as it is called in wood-shop parlance.

This rest has a number of functions. It carries three tools—a turning tool for reducing the square stock to round, a forming tool that produces a large part of the

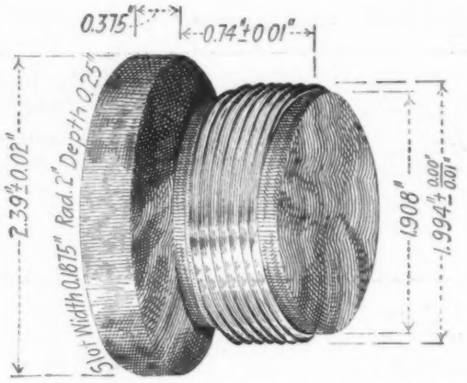
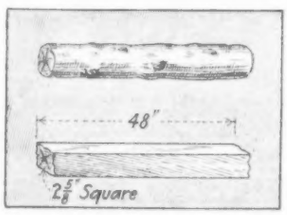
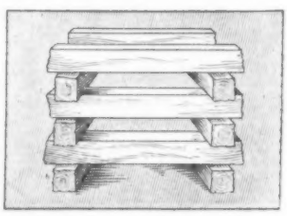


FIG. 2. PRINCIPAL DIMENSIONS OF THE WOOD FUSE-HOLE PLUG

FIG. 4. FIVE CUTTING OPERATIONS ARE COMBINED INTO ONE ON THIS TURNING LATHE





OPERATION 1: RIPSAWING LOGS

Machines Used—Portable ripsawing outfits.
Special Fixtures and Tools—None.
Production—Depends on size of logs available. Four rip cuts taken at from 150 to 200 ft. per min.

OPERATION 2: KILN DRYING

Machines Used—Dry Kilns.
Special Fixtures and Tools—None.

plug profile, and the cutting-off tool that severs the completed blank from the stick. In making the plug, the steady head is first fed along the lathe shears toward the

headstock, thus exposing sufficient of the rounded stock through the circular rest opening to allow of making one plug. The tailstock spindle is next advanced by means of

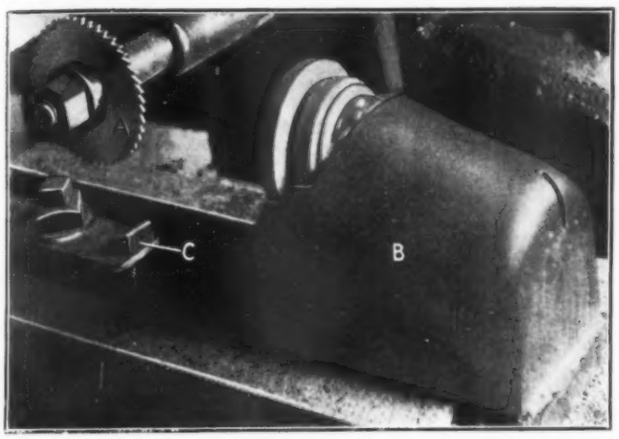
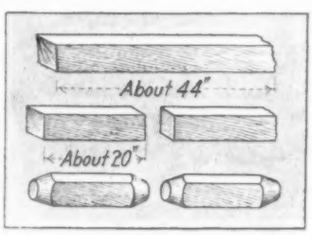
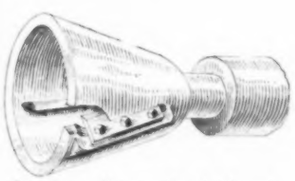
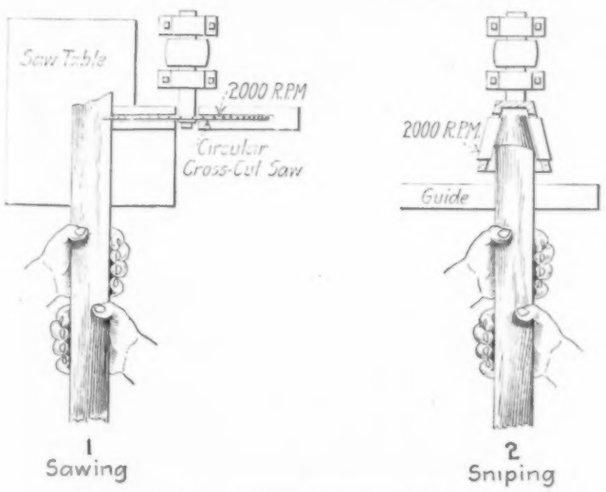


FIG. 5. SLOTTING IS ACCOMPLISHED BY PUSHING THE PLUG AGAINST A SAW BLADE

a hand lever, bringing the facing tool *B* and the beveling back-tool *C* into contact with the plug. By pressing a knee-treadle, the lathe hand next brings up the forming tool *D*, which swings on a pivot, into contact with the work. This same movement next causes the cutting-off tool to rise and completes the operation by detaching the plug. In the view, Fig. 4, the end of the stick is seen protruding through the rest just after the plug has been cut off. The forming tool *D* and the cutting-off




Section through Sniper showing Knives

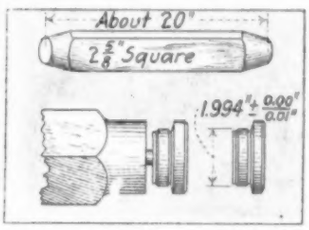


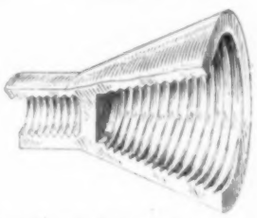
OPERATION 3: CROSS-SAWING AND SNIPING
Machines Used—Combination Sawing and Sniping Bench.
Special Fixtures and Tools—None.
Production—One man saws and snipes both ends of from 15,000 to 20,000 pieces per day of 10 hr.
Reference—See Fig. 3.

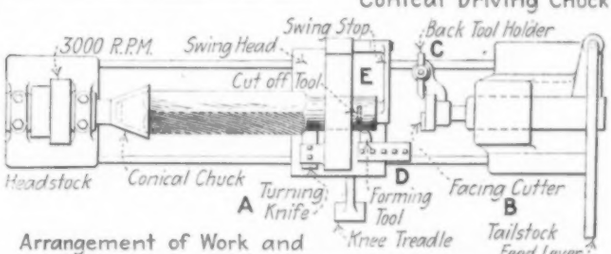
tool *E* are both clearly shown, and a glimpse is given of the back-tool *C* and of the end of the tailstock spindle that carries the facing cutter *B*.

The method of cutting the screw slot, which is done in the fifth operation, is quite similar to that employed in slotting metal screw-heads. A saw is used for this purpose, illustrated at *A* in both Fig. 5 and operation sheet 5. The plug, which rests in a simple chucking block, is pushed against the saw until the sliding block strikes the stop *C*. Fifteen thousand pieces per day from one machine and one operator is the usual production.

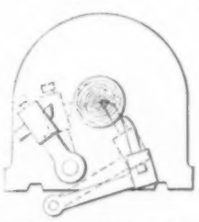
The method of making chucking fixtures such as used in this operation is quite simple. It consists in rough-

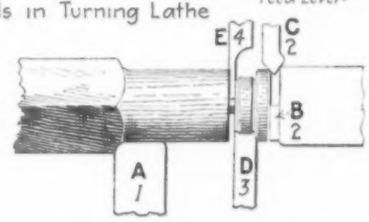



Conical Driving Chuck



Arrangement of Work and Tools in Turning Lathe


Action of Forming and Cut-Off Tools



Sequence of Operations

OPERATION 4: TURN PLUGS
Machines Used—Special forming and turning lathes.
Special Fixtures and Tools—Turning Knife A; facing cutter B; beveling tool C; forming tool D; cutoff tool D, special conical cup-screw chuck.
Gages—Ring gage for diameter of threaded part.
Production—One lathe and one operator, 8,000 pieces per day of 10 hr.
Reference—See Fig. 4.

ing out a recess in the block a little larger than the piece to be held, then securing the piece in the proper position and pouring melted lead around it.

The last operation, that of cutting the threads, is possibly the most interesting. One not familiar with how it is done conjectures all sorts of elaborate mechanisms. The machine shown in Fig. 6, which does this work,

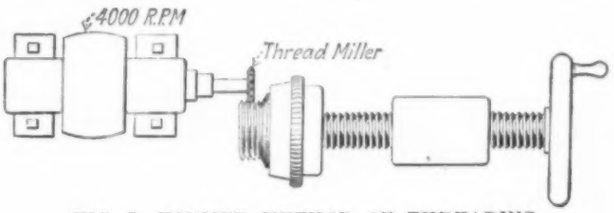
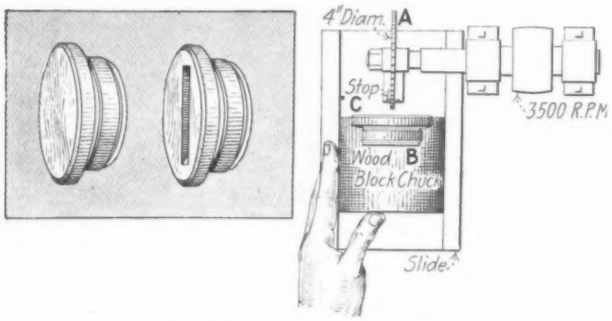


FIG. 7. FORMER METHOD OF THREADING THREAD MILLING

could hardly be more simple. The head and the tailstock swing upon a pivot *C*, the tailstock spindle serving simply to hold the piece in the chuck. Geared to the head spindle is the feed screw *D*. After the plug is placed within the chuck and held by the advanced tailstock

spindle, the operator presses down upon the tailstock lever, thus swinging the head and the tailstock on the pivot *C*, so that the feed screw comes in contact and engages with the single-thread bronze nut *E*, and at the same time the cutting tool *A* comes into proper relation with the blank to begin its cut. The action is exactly similar to threading with a single-point lathe tool. In the time that it has taken to read the description of this operation, the man running it would have completed some 40 or 50 plugs, for he turns out 15,000 in 10 hr.

This machine is a somewhat recent acquisition. Previously the method shown in Fig. 7 was employed. It

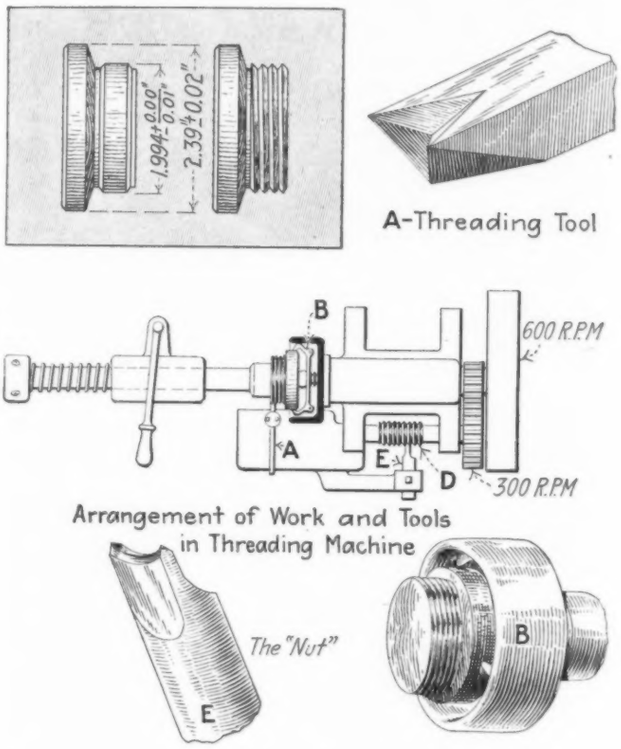


OPERATION 5: SLOTTING

Machine Used—Saw head and cross-slide.
Special Fixtures and Tools—4-in. cross-cut saw A; sliding wood chuck block B; position stop C.
Production—From one man and one machine, 15,000 pieces per day.
Reference—See Fig. 5.

is interesting to note that this is analogous to thread milling, just as the present method corresponds to threading with a single-point tool.

It is interesting to note some of the elements, simple yet carefully thought out, which make the remarkable increase in production noted in operation 6 in comparison with the alternate methods shown in Figs. 7 and 9 in which the production is 50 per cent. less. The greater part of the time-saving in the processes carried out with a special machine illustrated in Fig. 6 is due to not having to stop and reverse the spindle. This may seem a small matter on one individual plug, but where there are twenty or more of these turned out every minute, it amounts to a considerable saving in time in the course of the day's run.



OPERATION 6: CUT THREAD

Machines Use—Special threading machine.
Special Fixtures and Tools—Square notched threading tool A; special self-acting chuck.
Gages—Ring thread gage for thread.
Production—From one man and one machine, 15,000 pieces per day.
Reference—See Fig. 6. Former method of milling threads illustrated in Fig. 7.

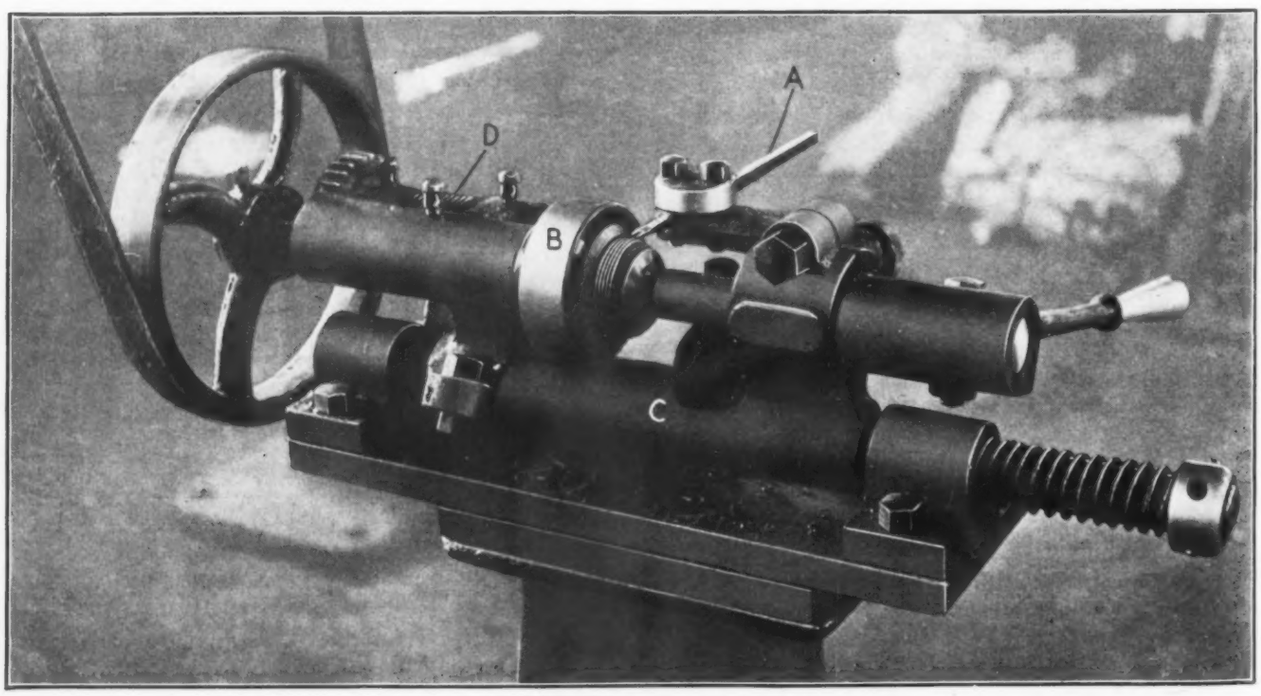


FIG. 6. SPECIAL MACHINE FOR THREADING WOOD FUSE PLUGS

The machine-shop man's usual conception of the coarse limits required in woodworking is somewhat upset by what he sees at the Estes plant not only in the case of the fuse plug, but on other work. Small cylindrical hollow boxes with both slip and screw covers are produced by the thousands, the parts being entirely interchangeable and in all cases a nice wringing fit. After all, there is no reason why well-seasoned hardwood should not be an ideal material for accurate machining. The fact that

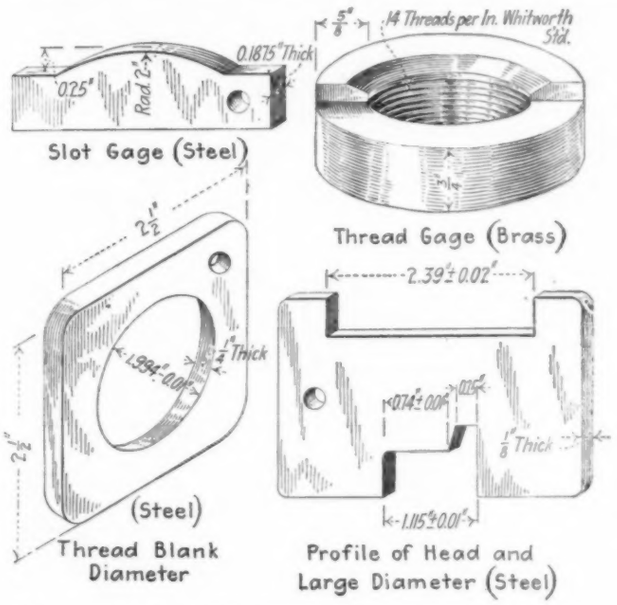


FIG. 10. GAGES USED IN INSPECTING WOODEN FUSE HOLE PLUGS

the cutting tools need no attention for weeks and months at a time does away with one very serious obstacle in size maintenance that is encountered daily by the metal-worker.

It will be of interest to add to the foregoing description outlining the process of making fuse-hole plugs a few words regarding alternative methods observed in a Western woodworking plant.

The method of threading in the Western plant is represented in Fig. 9. It should be noted that this differs from either of the foregoing threading methods, consisting in reality of a die-threading process. The die block *A* contains a hole having a continuous thread represented at *B*, interrupted only for the admission of the two tools *C* and *D*. The front tool *C* makes the preliminary cut and is followed by the threads *B*, which form a lead for the die. The rear tool *D* is used to clean out the last

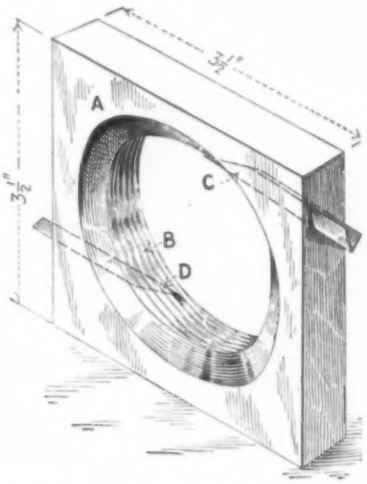


FIG. 9. DIE USED IN ALTERNATE THREADING METHOD

two threads, which are sometimes left a trifle rough by the leading tool *C*. The two inserted V-shaped tools cut the thread space and not the thread, and resemble a woodworker's triangular gouge.

Not only has the war made demands upon the forests of America for fuse plugs but also for wooden products of other kinds. In Fig. 8 several baskets will be noted in the left foreground. These are filled with wooden screw top boxes used as individual containers for spark plugs. By the time that this article is in print they, no doubt, will be on their way to England to serve their purpose in the Allied motor transport department.

It is not necessary to inspect fuse plugs very frequently, owing to the fact that size does not vary appreciably. At intervals, however, one or two plugs are tested to make sure that things are going all right. The gages used in this testing are shown in Fig. 10. They are all of the template variety with the exception of the thread gage, which is a brass ring partly recessed on the top.

FIG. 8. THE FINISHED PLUGS ARE SHIPPED IN BURLAP BAGS, EACH CONTAINING 1,000 PIECES

Machining a Large Albro Worm in a Small Lathe

By R. J. Mullin

During the summer of 1906 the North Coast Engineering Co., Seattle, Wash., was given a rush order for work on a steamship that was undergoing repairs at one of the marine shops. Among other things was a new worm of the Albro type, which was required for the steering engine, as in Fig. 1. Without ceremony of any kind the marine shop sent us a rough casting of the worm gear and a requisition calling for a finished worm in the shortest possible time. They stated that the shaft centers were 15 in. apart, but quite neglected to mention that they had attempted to cut one themselves and also omitted the usual request for a price in advance.

We had several A1 machinists, and our equipment was good as far as it went. Suggestions as to how that worm could be cut came thick and fast and were excused for cause just as rapidly, until finally nearly all gave it up. Presently I got an inspiration, and when the clanking of bar iron, the hum of the drilling machine and the rattle of bolts and nuts and wrenches had subsided, the Hamilton engine lathe was set up in a comparatively short time as shown in plan in Fig. 2.

As shown in Fig. 1, the thread of the worm must fit every tooth of the segment that it covers, also center lines drawn between the teeth of the gear and radiating from its center become the center lines of the thread at the point of contact. This means that the tool must have a length equal to the radius of the gear (12½ in.) and must swing from a fixed point corresponding to the center of the gear.

The outrigger bars *A*, Fig. 2, were cut off and drilled, and shallow grooves were cut across them where they rested on the shear strips. They were then firmly bolted to clamps beneath the lathe bed. The swivel-based vise *B* from the miller was placed on the outrigger bars with the center line *D* exactly 15 in. from the center line of the lathe. The tool *C* was the part requiring the greatest accuracy. It was made from a piece of 1-in. square steel, approximately 26 in. long. Since this worm was 1⅛-in. pitch and the coarsest lead the lathe would give was 1 in., it became necessary to proportion the two ends of the tool from the following formula:

$$9 : 8 = 12.5 : x, \text{ and } x = \frac{12.5 \times 8}{9} = 11\tfrac{1}{9}$$

this giving the length of the tool from the index line *E* to the slotted hole *F*.

A shoulder stud was made to fit in this slot, so that the length between *E* and *F* could be regulated as the cutting progressed. The reach rod *G* was connected to the stud in *F* and to the arm *H*, which was rigidly fastened to the carriage *I*. The rest *J* was placed under the tool and the set-up was complete. The lines *D* and *E* were a perfect guide for all adjustments.

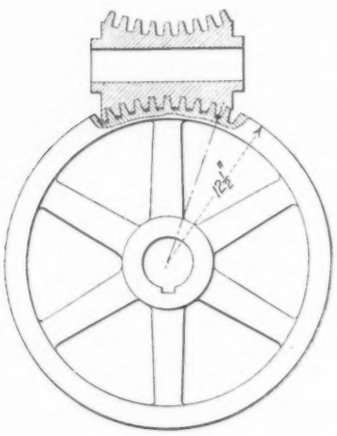


FIG. 1. ALBRO WORM FOR STEERING ENGINE

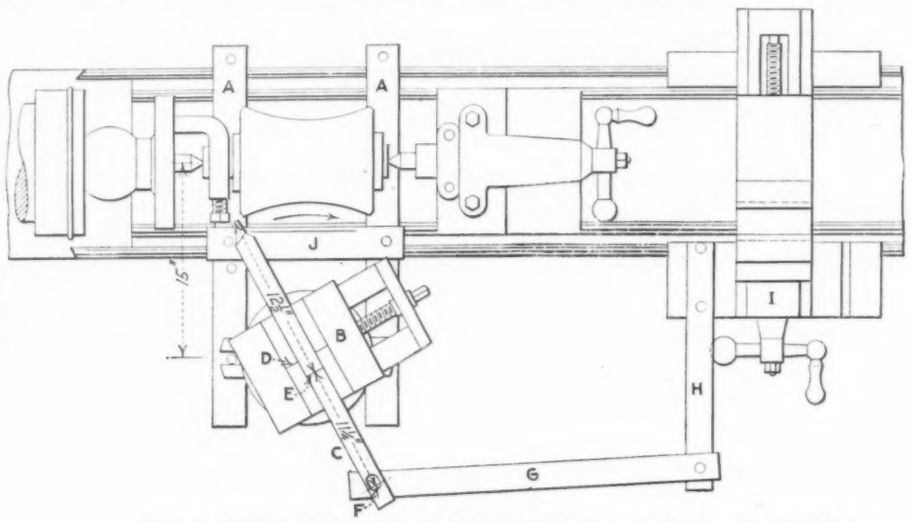


FIG. 2. LATHE SET UP FOR MACHINING THE WORM. MACHINING A LARGE ALBRO WORM IN THE ENGINE LATHE

After the blank was turned to size, the lathe was geared for 1-in. lead, and careful measurements were taken as the work progressed, with the result that a very good job was turned out in a remarkably short time.

The big laugh was on the foreman of the marine shop when he called the next forenoon to see how we were getting along. We had just completed the job and cleared the lathe. He confessed that they had tried it and asked us to show him how it was done.

Complex Alloy Steel—In a paper on alloy steels, which formed a part of a symposium presented before the International Engineering Congress, it was pointed out that practically none of the constructional steels contain three or more alloy metals. The only steel in this class to be considered is what is commonly known as high-speed steel. Robert Mushet developed and patented about 1860 an air-hardening steel that was very much superior to carbon tool steel for machining hard material. Mushet steel, as it was known, had about the following composition: Carbon, 2%; manganese, 1.75%; silicon, 0.75%; chromium, 0.40%; tungsten, 5.50%. At the Paris Exposition in 1900, the Bethlehem Steel Co. exhibited a new tool steel that took wonderfully heavy cuts at high speeds, the point of the tool heating up to a strong blue color without losing its edge. This steel, which immediately became known as high-speed steel, was the culmination of the research work carried on for many years by F. W. Taylor and concerning which he later published his monograph, "The Art of Cutting Metals." The difference between this steel and Mushet steel is apparent from the following typical composition: Carbon, 0.60%; manganese, 0.20%; silicon, 0.10%; chromium, 4%; tungsten, 18%. With this steel, cutting speeds of over 90 ft. per minute were obtained. Within three or four years it was found that the addition of vanadium to high-speed steel made it possible to greatly increase the speed and size of cut. At first only about 0.30% vanadium was added, but this has been increased until now 1% is practically the standard amount in most high-speed steels, and speeds of 140 ft. and upward per minute have been attained.

Living Up to a Reputation: The Small-Shop Miller

By John H. Van Deventer

SYNOPSIS—The influence of environment is as strong within the shop as it is out of it. Billy Fyles tells how a certain small shop lived up to the prestige of its new universal miller, thereby transforming itself from a small shop to a large one. Undoubtedly other things had something to do with this evolution; still, there is more truth than fiction in this narrative.

"Yep, it all come about because they bought a universal milling machine," remarked Billy Fyles as he probed for a splinter in the back of his grimy hand. We were discussing the remarkable growth of the Conners Consolidated Corporation, which a year or two previous had reposed under the less pretentious name of Conners Brothers Machine Shop.

"If I didn't know the reason, who would?" queried Billy defensively, noting the skeptical look on my face. "There ain't a foot of shafting or a hanger or a piece of belt in that shop but what I put there, an' I laid the foundation and set that miller myself just two years come New Year's day.

"I don't claim that the machine itself did it all—not by no means. But it started the thing going. It's like the case of the biled shirt and silk hat that made a congressman out of Tom Gerraghty. Mebbe if I tell you about him it'll help you understand the other.

"Tom was driver of a coal truck over at the East End. A well-set up fellow he was, too, for all that his face was like a bottle of ink eighteen hours out of the twenty-four. His old woman had advanced idees, and her ambition was that Tom should walk out with her of a Saturday night and Sunday arternoon rigged up in a biled shirt an' a stovepipe hat.

"I'll give Tom credit for not havin' no such notions himself. He managed to steer clear of the disgrace by holdin' out enough of his pay envelope for beer, so that after the rent and vittles were settled for there wasn't enough left to buy a postage stamp, let alone fancy togs.

"All would have gone well with Tom if his wife's uncle hadn't been unfeelin' enough to die and leave her fifty dollars. Next Saturday night, after things was settled an' Tom come home from work, there was a long-tailed coat and a biled shirt an' a stovepipe hat alayin' on the bed waitin' fer him. When he'd recovered from the shock, his wife led him to the kitchen and showed him a tub of hot water with a cake o' soap an' a scrubbin' brush settin' alongside.

"'Twasn't long afore Tom got used to his new duds and began to look forward to the end of the week so's he could parade in 'em. He noticed that instead of havin' to take to the gutter to let people by, folks made way for him when he was all togged out.

"It got so that Tom was ashamed of lookin' like a lump of coal on weekdays an' of comin' home with a dirty face. His wife kept apickin' at him about makin' somethin' better of himself, and afore long he was trottin' off to night school three times a week reg'lar. He'd never have kept it up if it hadn't been for the thought of livin' up to his biled shirt and top hat.

"After he'd learned to spell an' to drive a pencil he joined a debatin' society. He wasn't much on argument, but he was strong on appearance in his Sunday togs, an' his voice was powerful enough to win most of the debates that he went into. Bein' an Irishman, he had a nat'ral gift of gab, and when he needed a ten strike to even the score he'd bring down his big ham of a fist on the table with a bang that would convince most anybody.

"'Twasn't long before Tom Gerraghty was Democratic candidate for councilman, an' he carried the ward almost solid. Day after 'lection he bought himself a white velvet vest decorated with red trimmin's, an a new top hat twice as shiny as the old one.

"Well, sir, Tom kept progressin' and alivin' up to his new clothes—sort of hitchin' himself along up a ladder of top hats and swallowtails, so to speak. In a couple of years he bought himself a big diamond sparkler, an' right afterward this got him 'lected to Congress. If the decorations had held out, an' Tom hadn't smashed himself into kindlin' wood along with his new 90-horsepower roadster, nothin' could have kept him from bein' Governor of this state!"

Billy Fyles paused a moment to let the significance of this story sink in before proceeding with the analogous case of the Conners Consolidated Corporation.

One Foot in the Grave and the Other Slipping

"Sometimes a man needs somethin' of that kind to jar him out of a rut," he continued. "And you know yourself that Conners' machine shop was in a rut two years ago, if ever one was. There wasn't a man or machine in that shop in them days but what had one foot in the grave and the other on a banana peel—that is as far as any real usefulness was concerned.

"Ed Conners, bein' the older brother, had the best machine in the establishment, an' this was an 18-inch lathe that was new when Ed was a baby. In turning a straight piece of work, Ed used to watch when the carriage came opposite certain cracks in the wall back of the lathe, and favor the cut in or out as the case might be, to make up for the worn places in the shears. They do say that the tool chattered so bad that if a feller who didn't know the machine started to thread a bolt he'd be likely to turn out a grooved tap instead. Every time they tightened the belt they'd have to drive shims under the legs on the head end to bring the spindle back into contact with the bearings.

"Hennery Conners, the younger brother, pounded sand in their one-horse foundry and looked after the four other molders, who couldn't get work anywhere else. This department was as bad as the shop, and whenever they chucked a pig into the cupola everbody got ready to jump for fear it would knock the bottom out.

"Besides making stove grates and odd jobs they used to build a patent water lifter once in a while when there was nothin' else to do. It was a good little machine,

but nobody knew it, and the way they went at the making of them made them cost a lot more than they sold for.

"I can't imagine how they came to buy that miller; they must have got it for almost nothing at the bankrupt sale of the Fire Engine Co.'s plant. Anyway, it was a crackin' good machine, with feed handles and micrometer dials stickin' out all over it. I was mighty proud of the job when it was all set up, although it made the old relics around it look worse than ever.

"First Sunday after that I goes down to the shop to take out the slack of the belt. I must have come in rather quiet, for first thing I see was Ed and Hennery asettin' on soap boxes a little ways off from the new miller an' lookin' at it as if they was hipnertized. I sneaked out of there on tiptoe, feeling as if I'd butted in on a Quaker meetin' or something else sort of sacred.

Obstacles to Starting the New Miller

"When Monday come the Conners wanted to do some work with the new machine right away. Come to find out, there wasn't any millin' cutters come with it an' there wasn't a tool in the shop good enough to handle such a job as makin' 'em. Hennery comes out with the opinion that it's time they had a real lathe anyway, 'stead of a poor imitation that you dassent lean against for fear of its fallin' apart. I was that surprised when Ed agreed with him that I swallowed my chew and come near chokin' to death!

"A week or two after this I had the job of beltin' up a first-class lathe that had taper and relievin' attachments an' a gear feed. Now that there was another new tool to help things along, the shop began to look a little different.

"Ed turned up some cutters and notched 'em on the old planer an' turned a relief on 'em with the new lathe attachment—everything as smooth as silk till he comes to harden 'em. 'Gosh dumb it!' he says to Hennery, 'you can't expect a man to harden cutters on that tumbled-down pile of bricks that you call a forge!'

"'Who's askin' you to?' says Hennery. 'Ain't it bad enuf that I have to melt iron in that rusty old stove-pipe standin' over there in the corner, wot you call a cupola?'

Billy Fyles Has a Difficult Millwright Job

"Well, sir, the upshot was that Ed got his new forge and Hennery got a new cupola, bein' as the foundry hadn't had a look in as yet on the sprucin' up business. Ed hardened the cutters and made a first-rate job on 'em. He was as pleased as a kid with a new squawker until he come to think of grindin' 'em. All they had in the shop for grinding was a 14x2 snaggin' wheel that traveled up an' down an' sidewise nearly as far an' as fast as it turned around.

"I had quite a job riggin' up the new universal grinder that come the followin' week, on account of gettin' up the overhead works wrong side foremost at first an' havin' to face the machine around the other way in consequence. It was easier to dig up a satisfactory reason why the machine had to set that way than it would have been to take out all of them lagscrews and put the counter up twice.

"That millin' machine was a dandy when it once got goin'. Ed got together all the pieces of the water lifter that could be finished by millin' and in a day an' a half was around lookin' for more work to keep it agoin'.

"'I tell you Hennery,' says Ed, 'you've got to make me them water lifter castin's in 200 lots, 'cause I can't bother with less. An' please tell that broken-down bum that molded the last batch not to rap his patterns with a sledge hammer. What we need for these millin' jobs is good soft gray iron an' one-sixteenth for finish—neither more or less.'

"'What we need is a couple of moldin' machines, if you're goin' to be so partic'lar,' says Hennery.

"I wish you could see the job I done linin' up the new air compressor that had to be installed to accommodate the moldin' machines. While they was about it they got one big enough to run a bunch of hammers an' drills as well an' still have some wind left for more moldin' machines in the future.

"Don't think that the Conners boys let all of them new machines an' tools stand idle in the meantime. They wasn't the kind to see everythin' going' out an' nothin' comin' in without a struggle. Soon as they saw a hole in the shop they'd hustle around and dig up business to fill it. Somethin' like a vacuum a shop is—the more you try to keep it empty by hustlin' the work out, the more new work seems to try to get in. An' besides, there was more money an' higher grade work to be done with good tools than with the old junk that they'd had before.

"Things begun to get pretty crowded with all this new machinery, and it wasn't long before there was a new buildin' goin' up. All the old machines was discarded, and a man who had known the Conners place a year before wouldn't have believed it to be any relation—nor the Conners boys either, for that matter. They had a bunch of real machinists workin' for 'em an' had quit tryin' to use bums an' farm hands for molders.

New Designer and an Educated Foot Rule

"'Twasn't long after they got the new cost system workin' that Ed and Hennery found out some of the parts of the water lifter was costin' entirely too much account of the way they was made, and next thing they got was a crackerjack designer with a college dipplomy an' a educated foot rule that could do all kinds of figurin'. He went over that water lifter from A to Z an' made several improvements, an' cut the cost down about half, and made it lift twice as much as it done before. On the strength of that they was able to shave the price about a third an' took a contract with one of the big Chicago mail-order houses to furnish 'em water lifters in carload lots. Ed begun to travel over the country a bit to get idees an' look up business; an' hooked up with a export house in New York for a couple of shiploads of water lifters for South Ameriky.

"What with these an' other orders that come pilin' in, the business grew so fast that things got serious even with night an' day shifts. There was only one thing fer 'em to do, an' they done it—that was to buy up the Climax Works across the street—a plant that two years before hadn't known whether Conners Brothers was the name of a circus or a plumber's shop.

"That's the story of the Conners Consolidated Corporation," said Billy Fyles. "An' if it wasn't all brought about by that millin' machine, I'd like to know what else done it?"

What, indeed!

Machining a Magneto Pole Box

By Robert Mawson

SYNOPSIS—In this article are described the tools used when machining a magneto pole box. The quick-acting babbitting fixture used to attach the spacer is worth noting. The jigs used employ finished surfaces (either the bored hole or machined sides) to insure accuracy and interchangeability. A tong type of jig used for drilling holes in a rough casting employs a recess made with a contour similar to the part used as a locating medium.

The Henricks Magneto and Electric Co., Indianapolis, Ind., manufactures magnetos for automobiles and motor boats in several types and sizes. In Fig. 1 is shown one of the finished-machined pole boxes.

The babbitting fixture used for making the pole boxes is shown in Fig. 2.

Two of the rough castings *A* are placed in the fixture, being located by the arbor and wedges *B*. The cover *C* is then fastened back as shown with the handle *D*. The metal is poured between the two castings, thus uniting them. After the molten metal has solidified, the handle *D* is pushed back, which releases the cover. The pole box may then be ejected from the fixture after the arbor has been removed by means of the pins *E* operated with the handle *F*. The average time required for babbitting a pole box is 1 min. The inside of the pole box is then bored out to the desired diameter.

When drilling the holes in the pole box for the end bearing the jig shown in Figs. 3 and 3-A is used. The jig is provided with a turned plug which fits into the bored hole. The casting is located by the parallel *A*, which is set up with the wedge *B*. When the parallel is set out sufficiently to bring the casting square, four No. 20 holes are drilled in the box through the bushings *C*.

The jig employed for drilling the holes in the pole box to hold the magneto shoe is shown in Figs. 4 and 4-A.

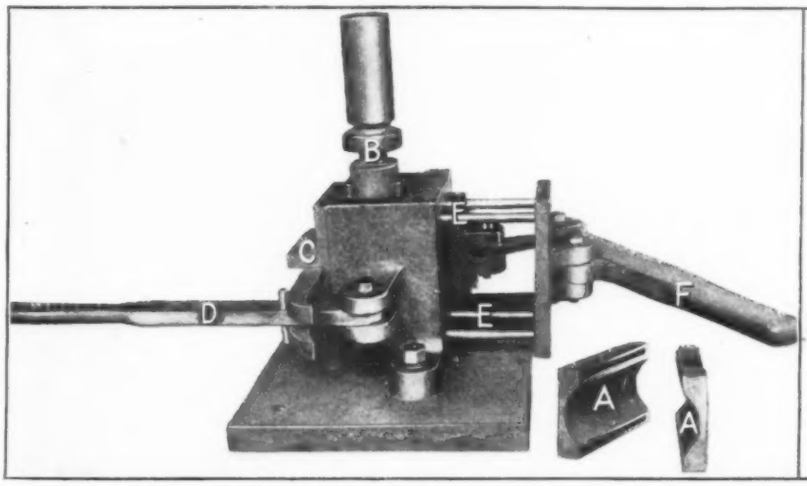


FIG. 2. BABBITTING FIXTURE FOR BOXES

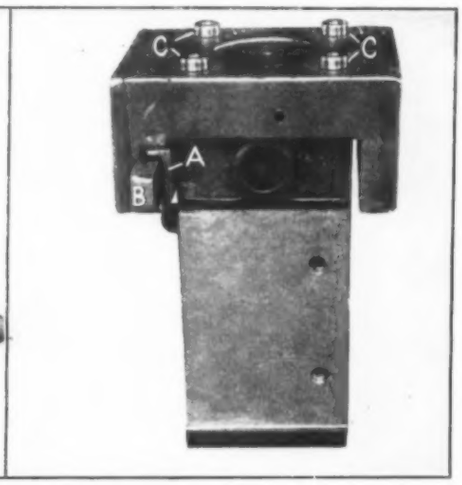


FIG. 3. JIG FOR BEARING HOLES

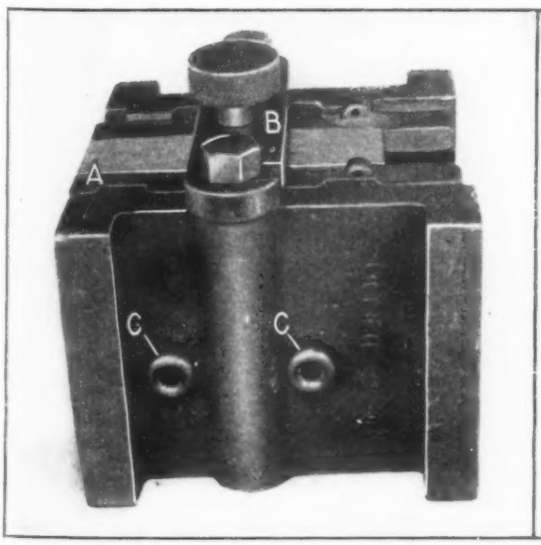


FIG. 4. DRILL JIG FOR MAGNETO HOLES

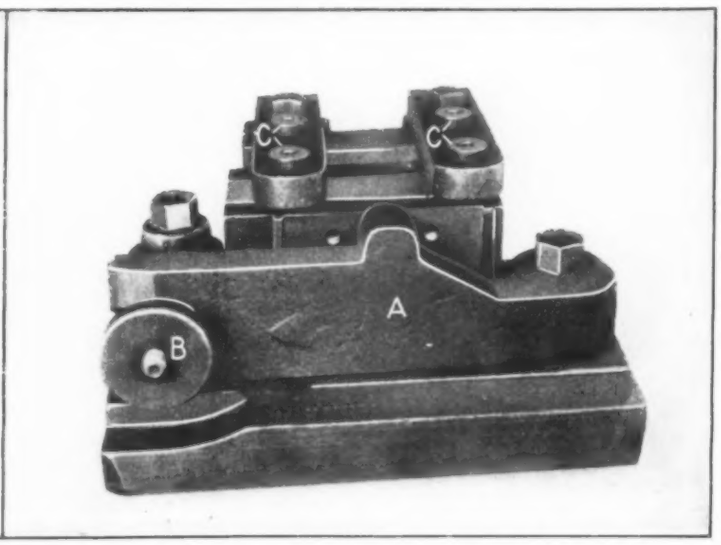
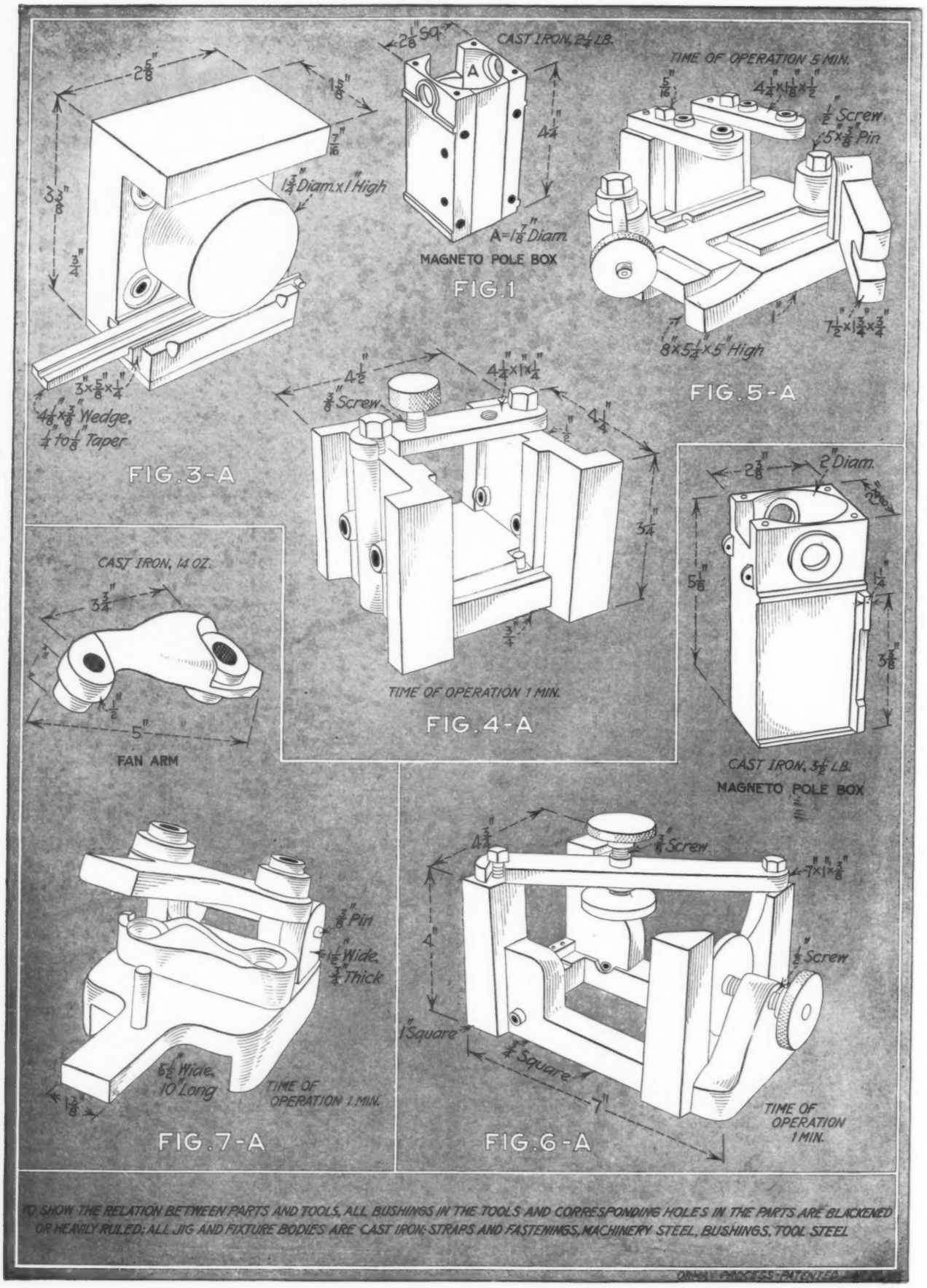


FIG. 5. DRILL JIG FOR HOLES IN BASE



DETAILS OF JIGS AND FIXTURES USED IN MACHINING A MAGNETO POLE BOX

The part is located in the jig by finished strips, the space between being made to suit the machined sides of the pole box. It is slid along until the ends come flush at *A*. The strap *B* is then swung into place and the knurled-head screw tightened down to hold the part in position. Four No. 8 holes are then drilled, two on each side, the tool being guided through bushings at *C*.

The jig used when drilling the holes in the base of the pole box is shown in Figs. 5 and 5-A. The casting is slid into the jig against a finished pad at the rear. It is then slid laterally until the finished flange rests against the end of the jig. The cover *A* is then swung back, the hook bolt slid into the slot in the cover and the knurled nut *B* is tightened, thus holding the casting in place. Four No. 8 holes are then drilled in the part, the tool being guided through the bushings *C*.

The jig used when drilling the holes to hold the name-plate on another type and size of pole box is shown in Figs. 6 and 6-A. The box has been previously babbitted, bored and milled as noted for the pole box described. The part is then dropped into the jig, after the cover *A* has been swung back. The part is then located by a machined disk operated with the knurled head screw *B*, which enters the bored hole. The casting is forced back against a stop pin at the end, after which the cover is swung around and the clamp *C* tightened to the part with the knurled-head screw *D* to hold it in position. Two No. 37 holes, one on each side, are then drilled, the tool being guided through bushings as *E*. To remove the pole box it is only necessary to slacken back the clamp and swing the cover back. The locating disk being screwed back, the part may then be removed.

For drilling the fan arms the jig shown in Figs. 7 and 7-A is used. The rough casting is located in the jig by a recess with a contour similar to that of the part. This may be seen better by referring to Fig. 7-A. The cover *A* is then dropped down, and as the operator grips the handles of the jig, sufficient pressure may be exerted to hold the part in position. A 37/64-in. hole is then drilled through the bushing *B* and a 3/8-in. hole through the bushing *C*. The latter hole is afterward tapped with 7/16-14 U. S. S. threads.

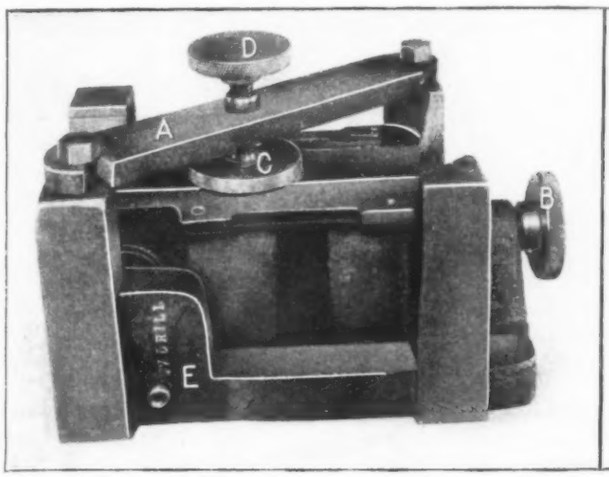


FIG. 6. DRILLING HOLES FOR NAMEPLATE

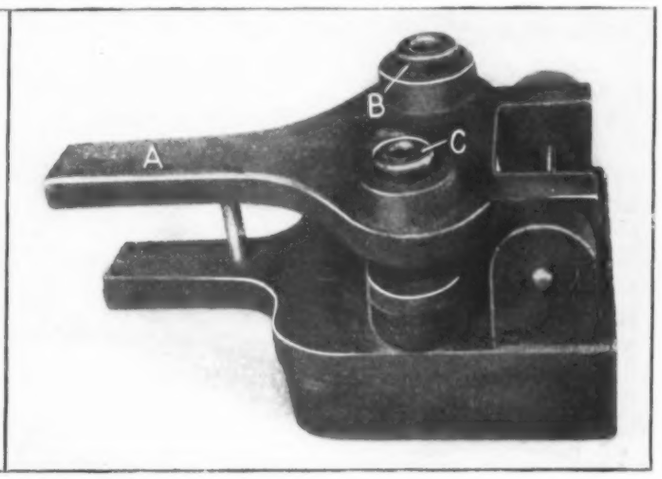
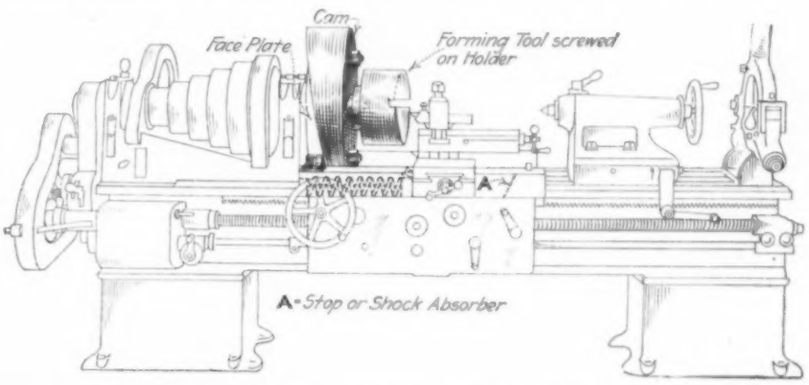


FIG. 7. DRILL JIG FOR FAN ARM

Making Spiral Forming Tools

By Charles Homewood

The sketch shows a method I used to make some spiral forming tools. They are usually made with a relieving attachment, or the next best thing is to use the lead screw and set back the carriage every time a cut is taken. Although this method is somewhat slow, I had decided to use it, but found I could not get enough lead. I might mention that these forming tools are used in finishing the nose on 18-lb. high-explosive shells and form an angle inside and outside and therefore have to have plenty of clearance—in other words, a big lead. The greatest lead I could obtain with the lead screw available was 1 in. I wanted a 1½-in. lead; and as we had no facilities for making a special gear, I proceeded to scratch the bald spot in my mental toolbook to see if I couldn't dig up some idea that would enable me to do the job. In a short time I found the way, and with the aid of pencil, paper, patternmaker and molder I was soon making forming tools in very good style. The outfit consists of a cast-iron plate with a cam-like edge extending halfway round it, one point



LATHE SET-UP FOR MAKING SPIRAL FORMING TOOLS

being ¾ in. higher than the rest. This cam plate was faced off on one side and the cam edge filed up a little to remove its rough surface. Next two slots were put in so as to match up with the slots in the faceplate, but in an opposite direction to allow for adjustment. A line was then scribed exactly across the center of the faceplate and the cam plate bolted to the faceplate, a line scribed on the cam plate matching with one end of the line already scribed on the faceplate. This was done so that when one side of the forming tool was finished, the cam plate could be turned round and the line on it matched up with the other end of the line on the faceplate, to finish the other side of the forming tool. Next a steel plate with a hardened roller in its center was bolted across the carriage of the lathe. A strong spring was laid in the lathe bed, one end resting against the headstock, the other against a wooden block, which in turn rested against the lower part of the cross-slide. As the lathe spindle revolved, the cam plate pressed against the roller, bringing the carriage forward until the high part of the cam had passed by the roller; then the spring forced the carriage back quickly against a stop or shock absorber, consisting of a block of wood with a rubber nailed on one end. The stop also rested in the lathe bed, one end of it against the tailstock.

Mold for Clay Crucibles

By A. R. Cooper

In placing our centrifugal casting machine on the market, we found that the little clay crucible shown was not easily obtainable in the United States, and we were referred to English and French manufacturers of such products.

The chief difficulty lay in the fact that this crucible had an overhanging lip shown at *O*, Fig. 1. Of course, it could have been made in several of the larger factories which specialize in this kind of work, had we been in a

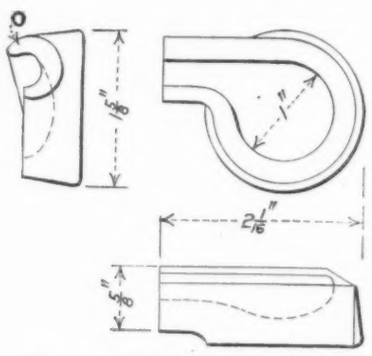


FIG. 1. THE CLAY CRUCIBLE

position to place a large order. But as five hundred crucibles were sufficient for our purpose and it being essential that they be gotten quickly and cheaply, we made them ourselves by the following method:

Two pieces of cold-rolled steel *L* and *K* (Fig. 2) were fitted together with a dovetailed slide and an adjustable plate to take up wear. The junction of the two pieces at *XX* was carefully made so as to be perfectly tight. The pieces, after being fitted together, were chucked in the lathe and the form of the crucible *M* bored out. This form is connected to the compression tube *C* through the hole *B*. The plate and handle *A* are fastened to the top of the mold by a C-clamp. This plate is removable only on the same angle of the guide pins *P*. The core of the crucible is made by placing the forming plate *N* and the recess *O* on the plate *A*.

In operation, the surface of the core *N*, recess *O* and hole *M* are wiped slightly with oily waste. The tube *C* is filled with refined fireclay mixed with water to the proper consistency. By turning the plunger screw *F*,

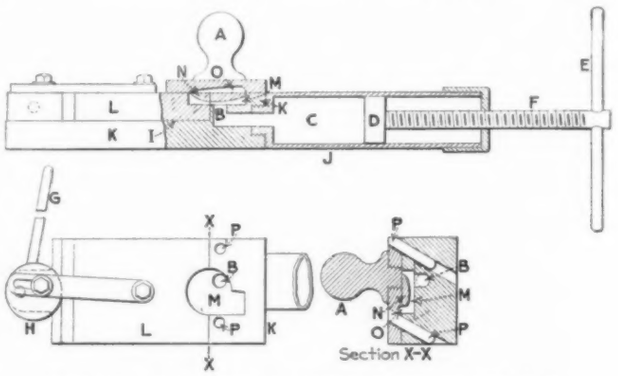


FIG. 2. MOLD FOR MAKING CLAY CRUCIBLES

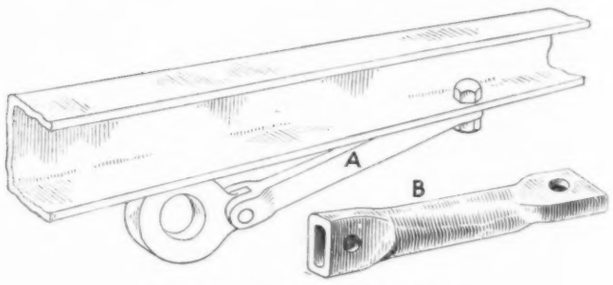
the clay is forced with a heavy pressure through hole *B* into the mold. Now, by means of the cam lever *G* the upper half of the mold is moved outward, opening it at *XY*, the plate *A* having first been removed.

After removal from the mold, the crucibles are allowed to air-dry for 24 hr., and then placed in the drying oven. The final baking is done in about two hours at a temperature of about 1,000 deg.

An Improvised Frame Brace

A little Metz runabout of the vintage of 1913 came in minus a brace between the jackshaft and the frame. This was a round brace, with eyes forged at each end and at right angles to each other. The frame end was also bent, as can be seen in the illustration.

Not having any facilities for forging a new brace



AN IMPROVISED FRAME BRACE

or for drilling the ⅜-in. holes if I could have forged it, I decided on another method. Wire or rod was out of the question, but I found a piece of ½-in. pipe of about the right length. The ends were heated in the fire and flattened at right angles to each other, as shown at *B*, one end being bent to fit against the under side of the frame.

The holes were easy to drill, as the metal was soft and only ⅛ in. thick on each side. A ⅛-in. drill in a small hand drill made the pilot hole very easily. Then a ⅜-in. drill in a carpenter's hand brace finished the job in short order. The improvised brace answered the purpose almost as well as a forged brace would have done.

Railway Shops at Tangshan, China

By Frank A. Foster

SYNOPSIS—The machine shop is perhaps as good a barometer of progress as any we can find, and from this basis we cannot fail to be interested in the development of the shops in the new republic of China. This shows the construction of some of the shop buildings, the interesting and ingenious devices for laying out and handling work and much else of general interest. As a possible field for machine-shop equipment of various kinds it deserves careful consideration.

The introduction of railroads and other engineering enterprises into China has made an ever increasing and imperative demand for foreign machinery far beyond the realization of most manufacturers in the United States, if we can judge by the scarcity of American machinery in the machine shops in various parts of China. These shops are multiplying rapidly in many localities, some controlled by foreign capital, others established with native money. Railroads that have been established with the aid of foreign capital almost invariably have machinery and foremen of their own nationality. Those that have been built directly by the Chinese have had a freer hand in buying the equipment they wished, and occasionally a preference is shown for machinery of American origin.

FIG. 1. RAILWAY SHOPS OF THE PEKING-MUKDEN LINE AT TANGSHAN, CHINA

An instance of the latter case is that of the Peking-Kalgan Railway, at the Nankow shops, 25 mi. northwest of Peking, where a fair proportion of American machinery has been introduced and appreciated. The chief engineer of this road, a Chinese, was educated in the United States.

A case of the foreign-built road is seen at Tangshan, on the Peking-Mukden Line of the Chinese Government Railway. This road was the first one to be permanently established in China, and its history is an interesting one. Starting, as it did, from a very small beginning in the early 80's, its struggles for existence were somewhat strenuous, because of general and official disapproval of such revolutionary innovations. A few of the events of its inception were recorded in an article in the *American Machinist* on page 1120, Vol. 35. From small beginnings this road has grown to a long and important one in a comparatively few years, and it is considered the best paying road in the world. The start was made by British effort, and it has always remained under British influence The heads of departments are still all British, although the road passed into the hands of the Chinese Government some years ago. A majority of the locomotives, all of the other rolling stock and practically all the machinery are of British origin. There are a number of American-built locomotives used on this line, the most recent acquisition being several Baldwin locomotives of a large type for hauling heavy trains of coal, in which traffic the road does a large business.

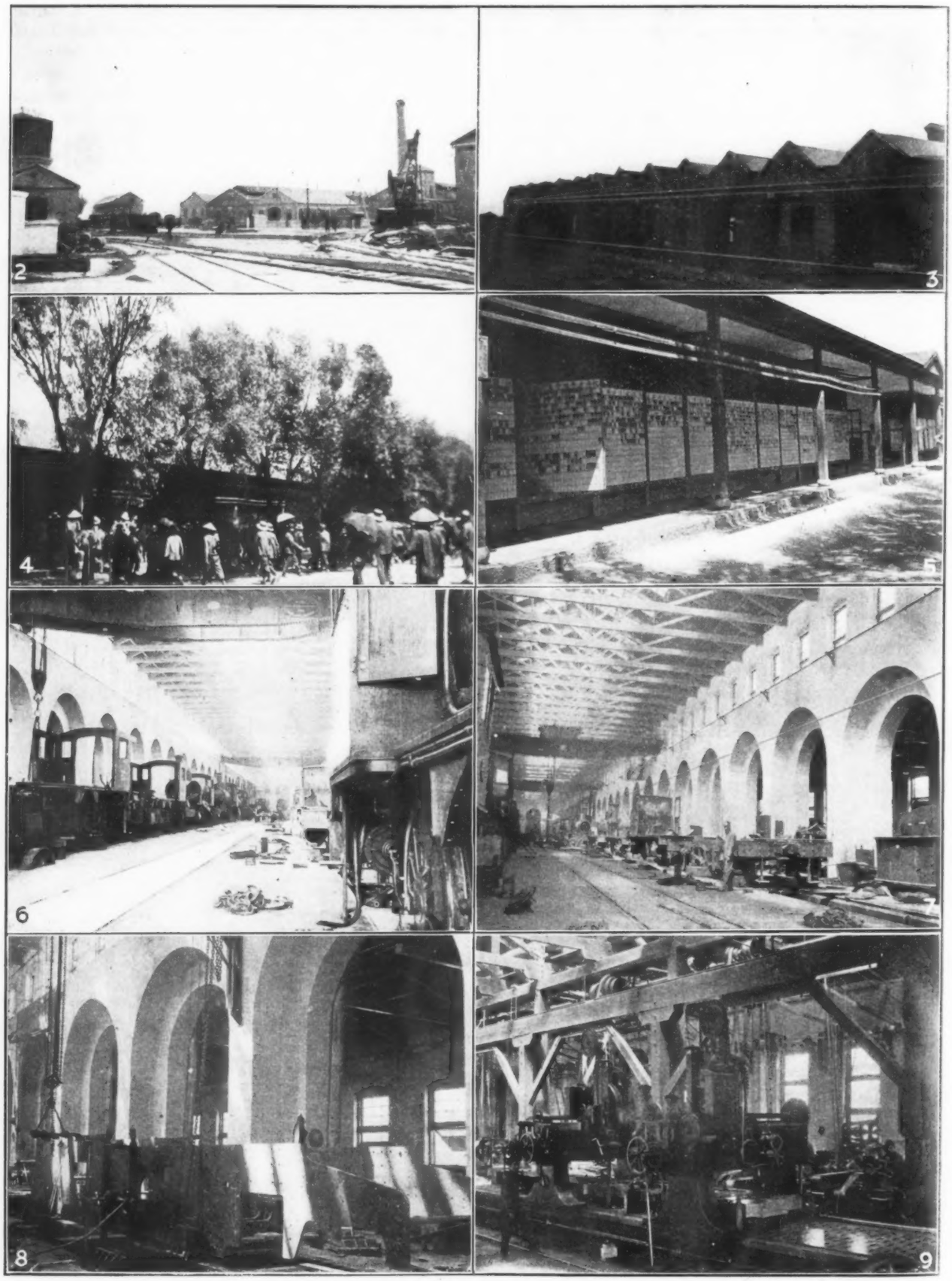
A description of the shops of the Peking-Mukden Line at Tangshan may prove of interest to the readers of the *American Machinist*, as it may give them a better idea of some machine-shop conditions in this part of the world and of the possibilities for introducing American machinery into China. In such a shop one finds much evidence of foreign influence, which, of course, is desirable, from a foreigner's point of view and is, also, generally appreciated by the Chinese themselves.

The plant is quite extensive and employs over 5,000 men. The exteriors of a few of the buildings are shown in Figs. 1, 2 and 3. These shops not only do the work for the Peking-Mukden Line, but also take contract work for some other government lines. Nearly all the Chinese railroads are under governmental control, and a very laudable attempt is being made to standardize the designs and methods throughout the country. Having a large amount of work done in one establishment and under foreign supervision is a factor in producing that result, and being taken early in the development of the industry, will have a far-reaching and beneficial effect.

The skilled mechanics here, as well as in other parts of China, are mostly from the province of Kwangtung (Canton). Of the skilled workmen, it can well be said that they are good mechanics and, under skilled direction, make very desirable help. They are inclined to be nervous and excitable, but are reckoned as loyal and energetic workers. Considerable work is done by contracts let out to different men. The men who work on contracts wear a badge to distinguish them from those who work by the day, and they have a separate entrance and exit from the others.

The day men are shown in Fig. 4, going out past the checkboards. These are located in front of a special time-record building near the entrance for day workers. Fig. 5 shows the arrangement of the checkboards. They are on pivoted panels so that the check side can be swung outward when the whistle blows for dismissal and back again to face the inside of the building after the time for the men to enter. One of the panels is shown partly swung around. The working hours are from 6:45 to 11:45 a.m., and from 1 to 6 p.m. in summer, and 1 to 5 or 5:30 in winter.

A good many young men are employed, and an efficient night school is maintained for training such of them as wish to qualify for higher positions than they hold at



FIGS. 2 TO 9. EXTERIOR AND INTERIOR VIEWS OF THE PEKING-MUKDEN SHOPS

Fig. 2—Yards and forge shop. Fig. 3—Car shops. Fig. 4—Entrance to the works. Fig. 5—The checking boards. Fig. 6—A bay of the erecting shop. Fig. 7—Another bay of the erecting shop. Fig. 8—Plate frame of a British locomotive. Fig. 9—Machine for drilling and slotting plate frames for locomotives of European design, showing slotting side

present. These classes are well attended and appreciated, for the average Chinese young man is ambitious and anxious to get ahead. The courses include mathematics, drawing and English, which is used more or less in this work. It is really surprising to what an extent English is used throughout China. One comes across men in the most unexpected places who can speak English of a sort, sufficiently well to make themselves understood. Many of the clerks and draftsmen employed on the road are trained in the company's evening schools.

Figs. 6 and 7 show the interior of a part of the erecting shop. This department is served by two powerful electric traveling cranes capable of lifting the heaviest locomotive and placing it anywhere in the shop. On entering this department, where there were twenty or more locomotives in various stages of erection or repairs, an observant American would be struck by the great difference between the style of frames used on locomotives of British origin or design and the American. The English engines have solid plate frames, in striking contrast to the open, or built-up frames of the American. Fig. 8 shows such a plate frame in process of erection.

The locomotive frames are erected on a massive cast-iron assembling fixture having the necessary adjustable

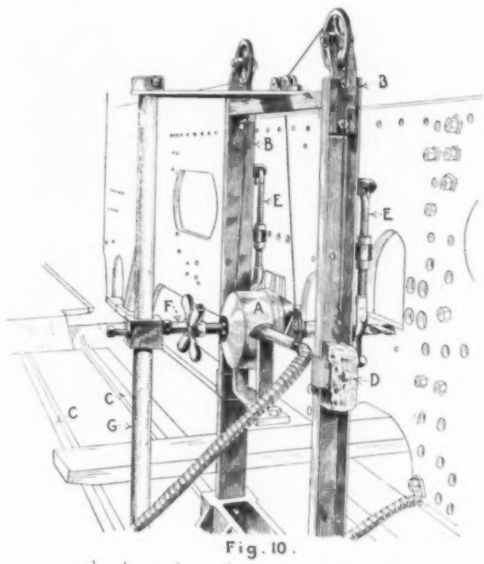


Fig. 10.

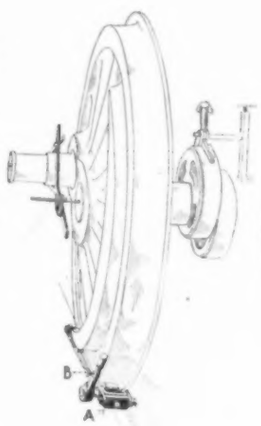


Fig. 11.

Fig. 12.

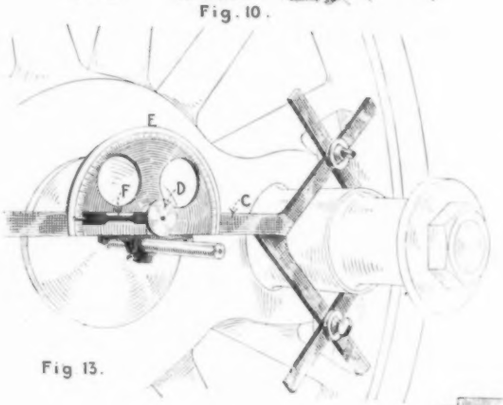


Fig. 13.

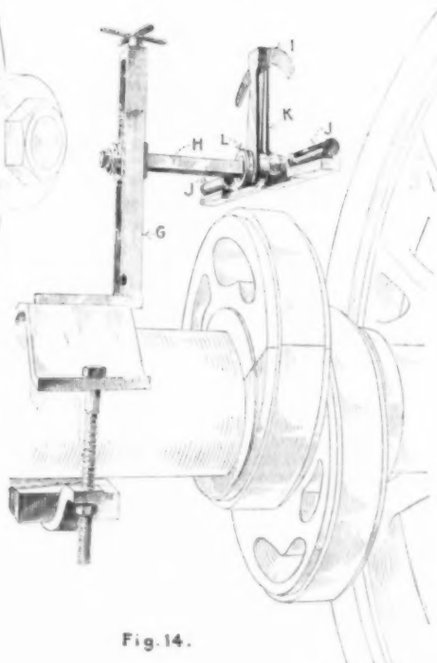


Fig. 14.

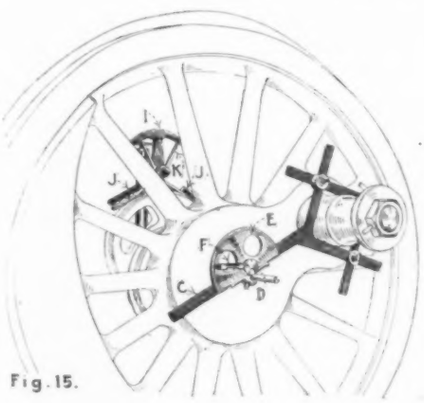


Fig. 15.

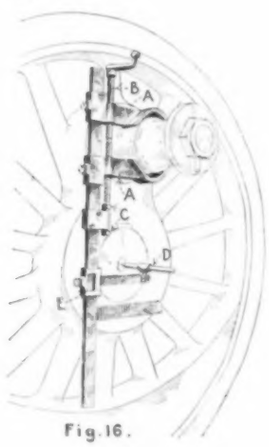


Fig. 16.

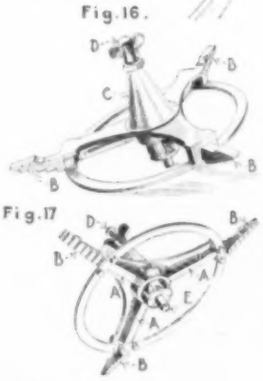


Fig. 17

FIGS. 10 TO 17. DEVICES IN USE IN THE PEKING-MUKDEN RY. SHOPS

Fig. 10—Compressed-air drill and support; drilling holes in a plate frame. Fig. 11—Rolls operated by a ratchet lever for revolving drive wheels when setting the eccentrics. Fig. 12—Tool for setting the crankpin at the required angle to center line. Fig. 13, 14 and 15—Part of device for setting the eccentrics at the required angular advance. Fig. 16—Device for measuring the throw of locomotive cranks. Fig. 17—Centering device for locomotive cylinders

fittings for locating all kinds of frames parallel and in line in every way, using the jaws of the axle bearings as locating points. A portion of the assembling fixture can be seen in Fig. 8 beneath the frame and at *A* between the axle jaws.

These plate frames are drilled and slotted out from imported English plates, on a special combination drilling and slotting machine, shown in Fig. 9. This machine has a long fixed bed over which are two heavy traveling heads carrying a drilling machine on one side and a slotting machine on the other. These are driven from shafts at the side of the bed and are fed longitudinally by large square-threaded screws, also at the side. Several similar frames can be drilled and slotted at the same time.

Fig. 10 gives a detail of the convenient arrangement for supporting a compressed-air drill for drilling the numerous holes needed in the sides of the plate frames for riveting and bolting the various attachments, as shown in Fig. 8. The drill frame is mounted on a solid trolley base, which travels on the rails *C* at the side of the assembling fixtures and can be supported from springing away by the adjustable rods *EE*, which can be attached to the frame plates. The drill body *A* is counterbalanced by weights *D* attached to it by small wire ropes passing over sheaves on the tops of the columns *B*. Pressure on the drill is obtained by the capstan-head screw *F* against the column *G*, which is attached to frame *B* at top and base.

Tools for Eccentrics and Crankpins

Another interesting feature noticed in the erecting shop was the convenient precision tools for locating the eccentrics on the driving axles, shown in Figs. 11 to 17. The manner of using these is as follows: The drive wheels are mounted on small ratchet-operated rolls *A*, Fig. 11 and Fig. 12, which are so placed as to raise the wheels slightly from the rails so that they can be revolved by working the ratchet handle *B*, Fig. 11. A self-centering arm *C*, Fig. 13, is attached to the crankpin and extending across the end of the axle, is centered there by the pointed screw *D*, which is adjustable along the arm *C* for different lengths of crank. To this arm is attached a protractor *E*, graduated to degrees and with its center on the screw *D*. There is also on *D* another short adjustable arm carrying a level and pointer *F*.

On the axle, inside the eccentrics, is another self-centering arm *G*, shown in detail in Fig. 14. To this arm is attached a square, horizontal, adjustable arm *H*, carrying a sleeve *L* on which are pivoted two right-angle bell cranks. One arm of each bell crank carries a level *J*, while the other arms *K* are pointed to indicate on a fixed, graduated dial *I*. The drive-wheel crank is first set level, by revolving on the rolls *A*, Fig. 11, until the pointer *F*, Figs. 13 and 15, comes to zero on the protractor *E*. The drive wheel is then revolved back until the angle indicated on protractor *E* shows the required angular advance. The self-centering arm *G* is then set vertical by levels *J* with the pointers *K* at zero, as in Fig. 15. The eccentric is then revolved on the axle to a position such that when the ends *J* are turned down to touch the eccentric tangentially, the pointers *K* both indicate equal distances from the zero point, as in Fig. 15. The eccentric is then in a position for marking the keyway. The other eccentric is set in the same manner after turning the driver forward.

A fixture for measuring the crankpin throw is shown in Fig. 16. The pin is gripped by the two V-shaped jaws *A*, which are moved by the right-and-left-hand screw *B* so that the center point between them is constant, the screw being held longitudinally by the collars *CC*. The adjustable pointed screw *D* is moved along the bar until it can be accurately inserted in the center of the axle, when the measurement can be read from the vernier scale at *E*.

Another convenient device in the erecting shop is for locating a center line through the cylinder. A fine steel wire was centered at the forward end of the cylinder by the appliance shown in Fig. 17 and extended along the side of the locomotive in the usual way for a working line from which to make measurements.

The centering device consists of three radially movable arms *A* sliding in fixed arms attached to the tapered central shell *C*. The outer ends of the arms *A* are a series of concentric steps, or shoulders, *B*. The arms *A* are forced outward by a tapered spindle sliding in the shell *C* and moved by the thumb-nut *D* on the forward end of the spindle. The concentric shoulders at *B* are thus forced against the inside of the counterbore of the cylinder and keep the spindle in a central position. At the rear of the spindle is a small chuck *E* in which the end of the small steel wire is gripped.

The device can be put in place very quickly and the wire be centered without any adjustment at that end. The shoulders *B* are so spaced that the device can be fitted into any diameter of cylinder used.

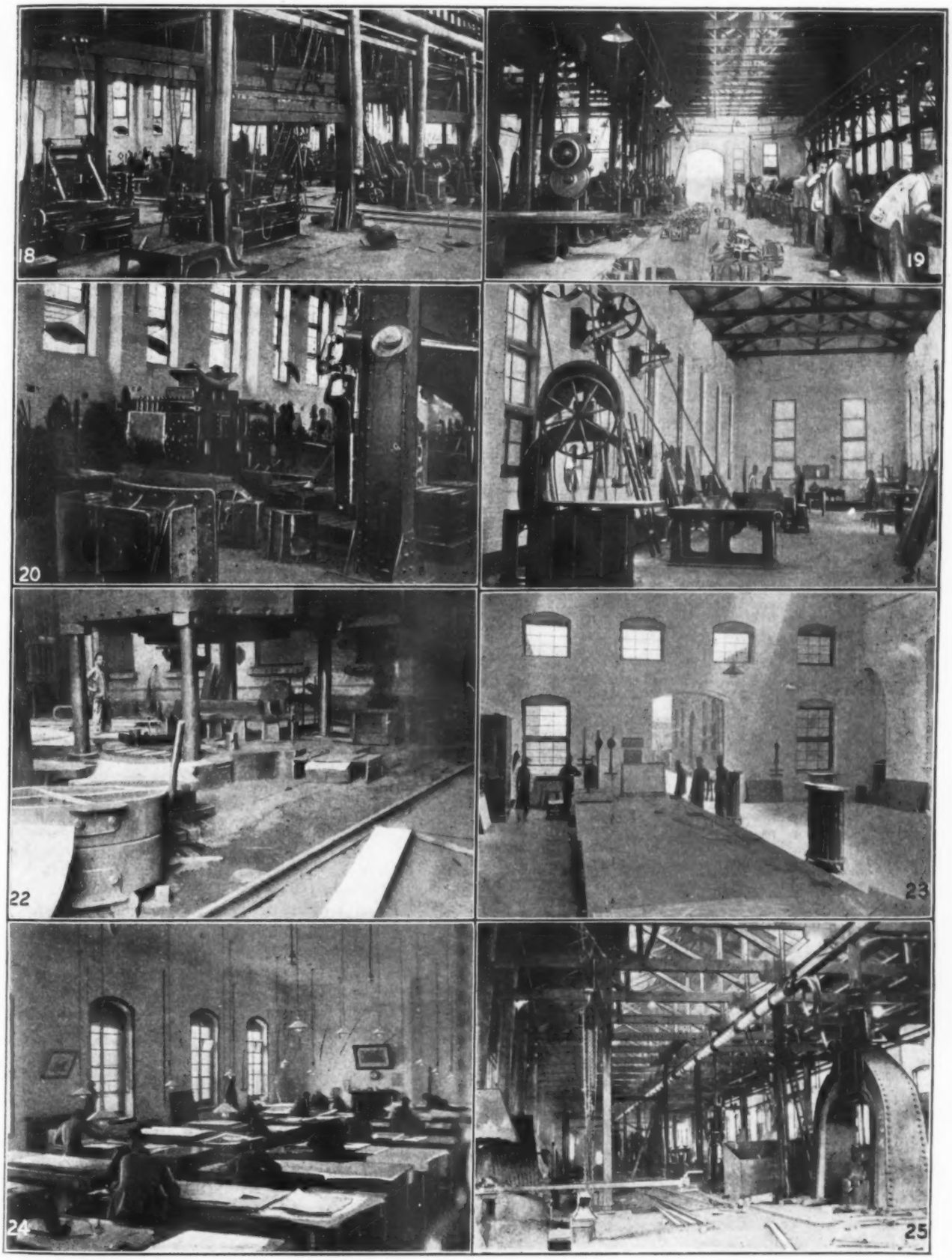
A small portion of the interior of the locomotive machine shop is shown in Fig. 18. In the center foreground can be seen the pipes for the hot-air heating system extending down the posts. The machine behind the nearest post is a new piston-rod grinder, which has been recently added. Observe the cast-iron fitters' bench in front of the post. Much of the machinery is of rather an old type, according to American ideas. Here and there, however, are machines which resemble in design and convenience those in good machine shops at home, but there was not a single milling machine to be seen in the works. Figs. 19 and 20 are also views in the locomotive machine shop.

The Car and Other Departments

A new pattern shop has recently been added to the plant, adjoining the pattern-storage house. Fig. 21 shows the interior to be a light and convenient place. The workmanship on the patterns would do credit to the best pattern shop in America, both as to execution and ingenious design.

Many of the departments are run by electric motors, although a few are still using steam engines. Electric lights are used throughout the works, all electricity being furnished from a central plant, which is continually being enlarged to meet the increasing demands. Compressed air is also used extensively and is furnished from a large central plant. Pneumatic hand riveters and drills are used everywhere possible.

The car department is a large and important feature of the Tangshan works. All kinds of cars are made, from the de luxe sleeping car to the little, single bogie (truck) coal car. The covered "goods" cars, or box-cars, as they are called in the United States, are of an all-metal type having a curved roof. The brakemen never go on top of



FIGS. 18 TO 25. OTHER VIEWS IN THE SHOPS AND DRAWING ROOM OF THE PEKING-MUKDEN RY.

Fig. 18—Interior of locomotive machine shop. Fig. 19—"Fitters'" benches, locomotive machine shop. Fig. 20—Erecting a large pair of cylinders in the machine shop. Fig. 21—The new pattern shop. Fig. 22—Press for forming car trucks. Fig. 23—Drafting room where the cars are laid out. Fig. 24—Drawing room, Chinese Government Ry.-Peking-Mukden Line, Tangshan. Fig. 25—Large steam hammer in forge shop

them. The brakes are controlled by the Westinghouse type or by hand brakes that are operated either by a screw and lever at the end or by a lever at the side of the car.

The trucks are of an all-metal type, many of them having pressed-steel members. These are formed on the powerful hydraulic press shown in Fig. 22. This press shapes up many other large pieces for boilers, etc., very successfully and fills a large sphere of usefulness, being kept busy nearly all the time. Some of the large dies used in it are shown at the left.

Many large, full-sized metal templates are used in the building of the cars, for locating holes, roof shapes, location of timber cuts, etc. To facilitate the making of these templates, a full-sized drawing is often made of a portion of a car, and of the trucks, from which the templates are laid out. Fig. 23 shows the interior of the drawing room where such work is drawn out on the large drawing boards there shown.

Fig. 24 shows the interior of the regular drawing room, where some 35 draftsmen are regularly employed under a foreign head draftsman. The workmanship on the drawings is remarkably fine and is said to be as accurate as the average of foreign work. The Chinese seem to be peculiarly adapted to such work, being very skillful with their hands, good mechanics and, above all, patient and painstaking.

The forge shop, shown in Fig. 25, is well-equipped with numerous steam hammers, hot and cold saws and similar tools. There are several steam hammers as powerful as the one shown in the picture, these being built in this shop.

China's Mechanical Development

Americans can draw an important lesson from a visit to such a shop, and the numerous illustrations have been given to show the size and scope of such work in China. This is not by any means an isolated case, but one of many springing up all over this great and rapidly developing country. Right here in Tangshan there are two other large manufacturing concerns, each employing about 5,000 men, and have good-sized machine shops which use machinery extensively. They are the Kailan Mining Administration and the Chee Hsin Cement Co. In Tientsin several thriving machine shops have started up within a few years. Railroads in various parts of the country are also equipped with extensive shops. It is the fixed policy of the Government to add railways as fast as finances will permit, as their economic value in building up the country on a firm basis is recognized.

In a new country a railroad has to bring its own patrons to develop the new resources of wealth made accessible. Here in China, a country having a population variously estimated at from a quarter to a third of the earth's people, there are vast tracts that have been well populated by an industrious people for centuries, but hampered from proper development by lack of transportation facilities—immense regions where there are no roads but foot-paths and the transport by donkeys or coolies' backs. Railroads entering such regions relieve the economic pressure, and immediately there is an influx of such kinds of trade as demand the use of machinery in exchange for the products of the soil and mine. The people are awake to the conditions and welcome the advent of the railway and what it brings to them.

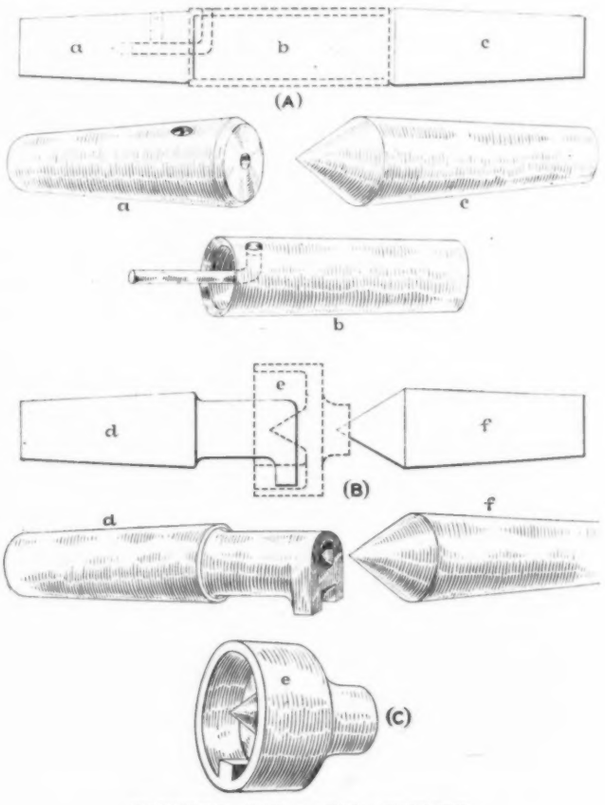
Aside from the building and equipping of railways and their necessary shops, a situation has developed that well illustrates how one industry affects many others, as pointed out in the *American Machinist*, on page 616. Railroad work, undoubtedly causes the development of an immensely broader field for all kinds of machinery and machine-made goods. Cotton, woolen and silk mills, oil mills (for peanut, bean and other oils), sugar refineries and, in the seaports, shipbuilding and repairing places are prospering. Then, too, there is the added development of agriculture and mining, stimulated by increased facilities for transportation. Everything of this kind reacts as a stimulus to machinery using and machinery building. Behind all this stand the machine tools and the machinist.

Who will supply these tools and machinery for all the change and development that is going on almost unknown to the average American manufacturer? Will it be Americans, or will they stand placidly aside and see the Europeans or the Japanese reap the harvest? It is up to the Americans to decide, but they will have to decide at once or, later, when the present rush is over, take their time to kick themselves for neglecting the opportunity.

Grinder and Lathe Centers

By Fred Fruhner

The illustration shows centers for grinding piston pins. The center *A* does away with the dog, thus saving time



GRINDER AND LATHE CENTER

in handling. A lathe center for turning castings similar to *C* is shown at *B*.

Practical Points on Jig Design--I

By Carl D. Wilder

SYNOPSIS—Practical points in jig design and construction are usually learned through expensive experience. In this article the results of many years of jig and tool design and use are compressed into a number of instructions which are placed in the hands of the tool-designing force.

The importance of a well-organized tool department in any shop cannot be estimated. It will pay large investments in even a shop of moderate size; but in order to be fully effective and well organized there must be basic lines of best practice laid down for the members of this department to follow.

The system outlined in this article is already in use in three well-known shops. It is not an experiment and was not originated by any one man, but was evolved through the experience of a number of men.

Jigs are marked with the symbol of the machine or the name in case objection is made to the use of symbols. All jig numbers consist of a letter followed by a numeral. The letter refers to the jig as a whole, while the number is different for each casting. If these are to be fastened together permanently when the jig is assembled, the main part is marked as usual, while the patterns of the combining castings carry the same numbers, except with an increasing numeral following the jig letter, as: Drill Jig DW37-B1, Cover Plate DW37-B2, etc. This is for convenience in finding the pattern, ordering the castings and routing them through the shop or tool room. These pattern numbers can be placed on surfaces which are to be finished so that they will be machined off in the tool room and the complete jig marking stamped on some finished spot on the jig body.

Marking Detachable Parts of Jigs

Loose parts that may be removed or laid aside during the process of shop operations, also special form cutters, gages, counter bores, gang cutters and the like, are marked in the same manner—with the machine symbol, part number, jig letter and a numeral in sequence with the jig-casting number. When the device as a whole is used for parts other than the one for which it is marked, a note to this effect is placed over the title, thus: "Also used for CW97."

The above-described method of marking tools I call the A-B-C marking, and I consider it the simplest and most practical marking system. In employing this system avoid the use of the letters I and O. They are sure to be mistaken for numbers. Some jig drawings require several marks to be stamped on the finished jig besides the jig number. For example, the positions of the necessary set blocks are indicated by arrows placed at the nearest convenient points showing where the set blocks are to be used.

The following are some bits of standard practice which will prevent misunderstanding in jig-designing, department and tool room.

On jig drawings finish marks are used only when finished surfaces are necessary for operating the jigs in the shop; but they may be finished anywhere to facilitate construction provided the solidity of the casting is not impaired.

When a part is located in a jig by its rough surface, the dimensions to the locating pins will be marked "Fit," meaning approximate only. This is sometimes given in nearest $^1/_{64}$ in. and must be modified according to the way the piece comes from the forge or foundry. When "Fit" is marked on the diameter of a push pin or locating arbor it means that the pin or arbor is to go easily, but without play, into the hole for which it is intended. A driving fit is called "drive" or "press."

On tool work, "Standard" or "Ream" means the exact size and not two- or three-thousandths either way. A fractional dimension—½, ¾, ¼ in., etc.—means a five-thousandths limit either way. Closer limits are put on in the usual decimal form.

Lining, Slip and Eccentric Bushings

Bushings should be made to standard plugs, so that tools entering can be made standard. Slip bushings are not stamped with the jig number but only with the size of the small tool used in them, and are so called for in the operations. They must be kept with their jigs. When slip bushings are used they must always be locked either with a screw or pin. The tool drawing does not call for the screw or pin, as these are considered standard parts. For locating lining bushings, mark the size on the casting near the bushing. Eccentric bushings are usually locked by a steel block against a flat made on the bushing head. When two bushings are located by the same number, corresponding to only one hole in the jig, and one bushing does not enter the other, it means that both are slip bushings and fit directly into the casting without a lining bushing. Such construction should be used only on temporary work.

In the case of a reamed hole or a hole tapped while the piece is in the jig, the operation may call for: "Spot, drill and ream," or "tap," as the case may be, meaning that a spot drill of full size of the reamer or tap is first used to mark the center of the hole, then the reamer or tap drill, then the reamer or tap itself. This method is used only where extreme accuracy is not required.

Set Blocks and Locating Holes for Jigs

Cutters are not set directly against setting spots. As a rule, standard set blocks in the form of steel disks, hardened and accurately ground, ⅞ in. in diameter and varying in thickness by $^1/_{16}$ in., are used. When necessary, special set blocks, the same as standard blocks, are employed as "feelers" between the tool and the set spot or under the tool. Special set blocks should have clearance holes for screws with which to fasten them to the jig, so that they can be kept out of the way when not in use.

On certain machines it is essential to have spots or holes to secure the proper location of the jig or fixture on the machine. To insure accuracy in fitting lathe jigs, a reamed hole is provided in the center of the jig, which is centered by a plug that fits both this hole and the taper shank of the lathe spindle. Rotary milling jigs usually carry a standard hole, located relative to the cutter or spindle of the machine. A standard collet and plug is

placed in the spindle and the table moved until the plug enters the standard hole in the jig. The slide is then clamped, the plug removed and the cutter inserted.

Profiling jigs, in order to accommodate themselves to different distances between the cutter spindle and the leader pin, are usually made in two parts. These parts are set respectively one to the other for a given distance between two finished spots on the halves.

Before designing a jig, fixture or special tool it is well to ask oneself the following questions: Is the part in question to be interchangeable? How many pieces are to be machined? What degree of accuracy is required and how much time, if any, will be gained by using the proposed tool? If no time is gained, will the increased accuracy of the product warrant making the tool? Can the jig be designed and time saved by doing several pieces at one fitting? Can it be made so that the operator can replace the finished parts while others are being done, thus making the machining continuous? In drilling, will it pay to make two jigs, rather than drill holes of great difference of size in one? Have you range of speed or capacity varying enough to drill such holes to advantage in one drill press?

On all jigs it is well to consider the size and shape of the machine table that the tool will rest upon and to have the feet or bottom of the jig made so as to give it the best possible support, especially if it will overhang the table. See if an auxiliary table large enough to hold the jig is available or if it would pay to make one.

Considerations in the Designing of Jigs

When designing jigs it is well to write preliminary operations, outlining the sequence in which proposed tools are to be used. This should be passed along to the checker with the tool drawings. Make all drill jigs as light as possible compatible with the strength needed. Light ribbing will add much strength and little weight. Boring, planing and milling jigs can be heavier, as they are not handled so much, and the need of strength and rigidity in them is much greater.

Arrange for taking care of milling, drilling, boring or planing chips. Cast holes in the jig so there will be plenty of room for cleaning. Avoid weak points that need strengthening and do not make parts a great deal stronger and heavier than necessary.

Avoid deep, narrow pockets that will not draw from the sand and also unequal sections of metal which will cool and cause warping and cracks. Place the ribs so that the pattern will not warp out of shape, and use core boxes and loose pieces only when the benefit derived exceeds the extra cost.

Have nothing in the way of getting needed oil or compound on the work. Provide oil holes for cover hinge pins or any other parts that need oil.

Be sure the pressure of the work and tool falls within the base. Make all supporting devices strong, rigid and easy to operate.

On drill jigs extend the feet to clear everything—the part itself, the bushings, clamp screws, etc.—on any side that the jig must rest upon when drilling from the opposite side. It is best to arrange for drill jigs to be clamped to the table of the drill press when possible. If not, and it is a small jig, have spots or sides finished so the operator can loosely clamp small parallels on each, so that the drill will not swing around.

Have all bushings as near to the work as possible, considering chip clearance, and do not allow "pockets," where chips can pack in around the drill. Locate the work high enough, so that you can drill and ream through without hitting anything. If there are tapped holes you can usually tap them in the jig by using a slip bushing for the drill and tapping through the lining bushing without a guide. It is seldom necessary to use a guide bushing to hold a tap straight.

On long fixtures locate the ribs so that there will be no danger of the jig buckling when milling cutters pass over it, and take care to leave no place where chips can bank up in the cutters. On milling fixtures, when the "straight edge" is called for instead of ordinary set blocks, look out for interference from seats, blocks and the like.

On boring fixtures bore against solid stops, if possible. Use straight bars where practical and make slip bushings so that the bars can be put through the jig from the back end without moving the table from its setting. Always use a floating holder when a boring bar is supported by bushings at both ends. Leave clearance for reamers, counterbores and the like to be assembled on the bar, so that they may go through the holes without hitting the bushing.

In a series of jigs for one piece it is very important to locate the work from the same spots or surfaces in all of the jigs. If from the rough in the first jig and from a finished hole or surface in the second one, all the succeeding jigs should locate from the same finished hole or surface. When you locate from the rough casting consider whether the spot is to remain rough or be finished off in some future operation. If it is to be finished, you must allow from $\frac{1}{8}$ to $\frac{3}{16}$ in. finish over the drawing dimension.

Applications of Vanadium Steel have up to now been generally restricted to a chromium-vanadium steel of the following typical composition, according to a paper read before the International Engineering Congress: Carbon, 0.10% to 0.55%; manganese, 0.50% to 0.80%; chromium, 0.80% to 1%; vanadium, over 0.15%. The lower carbon type, 0.10% to 0.20%, is used mainly for case-hardening and is the best steel for this purpose. It carbonizes readily, gives the highest maximum carbon and finest grain. The casing is very strongly coherent to the core, very hard, tough and strong and practically free from any tendency to flake or powder. The core is remarkably strong and tough. The higher limits of carbon, 0.45% to 0.55%, are extensively used for automobile and locomotive springs, giving remarkable resiliency and endurance. It is also extensively used for oil-tempered gears. The range in carbon from 0.35% to 0.45% is largely employed for crankshafts, locomotive axles, crankpins, connecting rods, hammer piston rods, automobile transmissions and rear-axle shafts. The range from 0.25% to 0.35% carbon is used for automobile forgings of all kinds and a great variety of miscellaneous work requiring the best combination of static and dynamic strength. As illustrating the wonderful shock- and fatigue-enduring qualities of chrome-vanadium steel, drop-hammer piston rods of this material are giving many times the length of service of carbon, nickel and chromium-nickel steel rods. Chromium-vanadium steel forges and machines better than nickel-chromium steel, is not as liable to injury in heating for forging, is not so liable to crack or check in heat-treatment and is free from the seamy tendency of steel containing nickel. Carbon steel with a small percentage of vanadium, from 0.15% to 0.20%, has been used extensively for locomotive-frame castings with great success. The failures of these frames from all causes over a period of nearly 10 years has been only a fraction of 1%. In tool-steel grades, this steel has better cutting qualities, hardens deeper and more uniformly and has remarkable toughness. In what are termed battering tools, chisels, cutters, dies, etc., it gives several times the length of service of ordinary carbon tool steel. Tests of carbon-vanadium steel rails in curves are showing that they wear about 20% less than rails with 0.15% to 0.20% higher carbon and are also considerably stronger. Higher carbon percentages will no doubt greatly increase the difference in wear.

Hand Die-Casting Machines

By Ethan Viall

SYNOPSIS—The hand-operated type of die-casting machine here described differs from the pneumatic type in that the metal is forced into the dies by means of direct mechanical pressure. For certain classes of work these machines seem to have a number of advantages over the more costly type. The dies used are practically the same as those employed in other machines, the difference being in the machine itself.

Some of the advantages claimed for the hand-operated type of die-casting machines are that they are comparatively cheap to make, that the cost of upkeep is small and that an experienced operator can tell by the "feel" of his feeding lever just what kind of casting he is making. While naturally the dies must be vented, there is no danger of escaping air getting into the melted metal and causing porous, or "bubbly," castings.

The Milwaukee Die Casting Co., Milwaukee, Wis., makes bearing bushings, babbitt-lined bronze-back shells and small castings of all sorts. Its shop has turned out castings as large as 8 in. in diameter, weighing 5 lb., and others up to 6 in. wide and 14 in. long. The toolroom and shop are well equipped for making dies and turning out almost any work that can be successfully die-cast. A large number of die-casting machines of various sizes are in constant operation. The hand-operated type of machine used by the company will be described here with enough detail to give the reader a good idea of how it works.

One of the machines in casting position is shown in Fig. 1. The cross-handled lever that operates the plunger by which the melted metal is forced into the die is shown at *A*. The die cage is carried on a heavy forked base hinged at the rear. This base is held down while casting by means of latches at *B*, which are operated by the foot treadle *C*. In operation the workman takes hold of the cross-handle and pulls. This forces a plunger near the bottom of the pot inward and causes the melted metal to run upward into the die.

The same machine, with the die cage thrown back, is shown in Fig. 2. The die cage is counterbalanced by means of a weight and the rope *D*, which runs over a pulley. This makes it easy for the die operator to swing the cage back onto the rest for the removal of the casting. The lever nut and rod *E* shown between the forks of the cage base are for locking together the two parts of the die for the cast. There are two of these locks, one at the front and the other at the back. When these are released, the two parts of the die are separated by means of a toggle and lever. The metal pot is shown set into the base of the

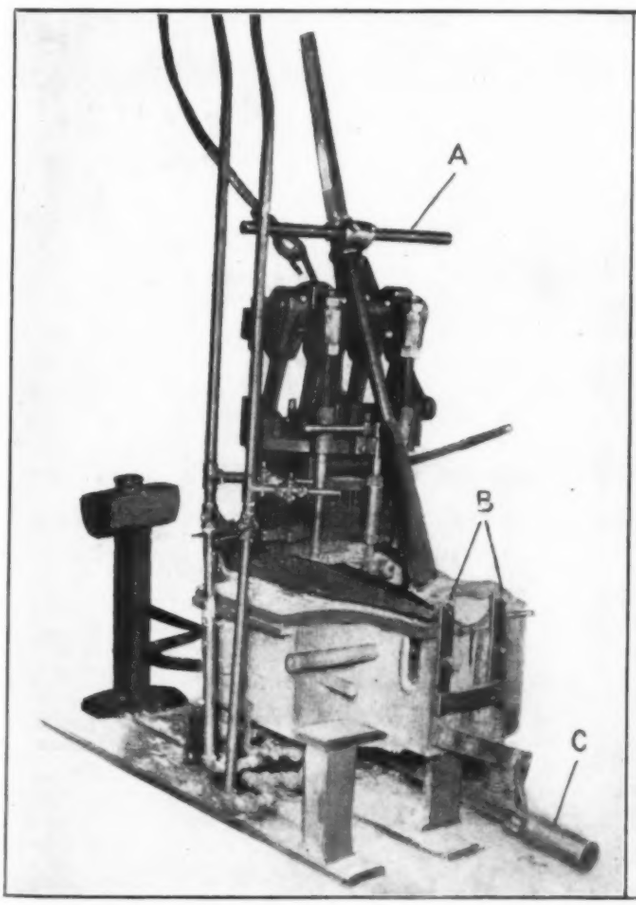


FIG. 1. HAND-OPERATED MACHINE IN CASTING POSITION

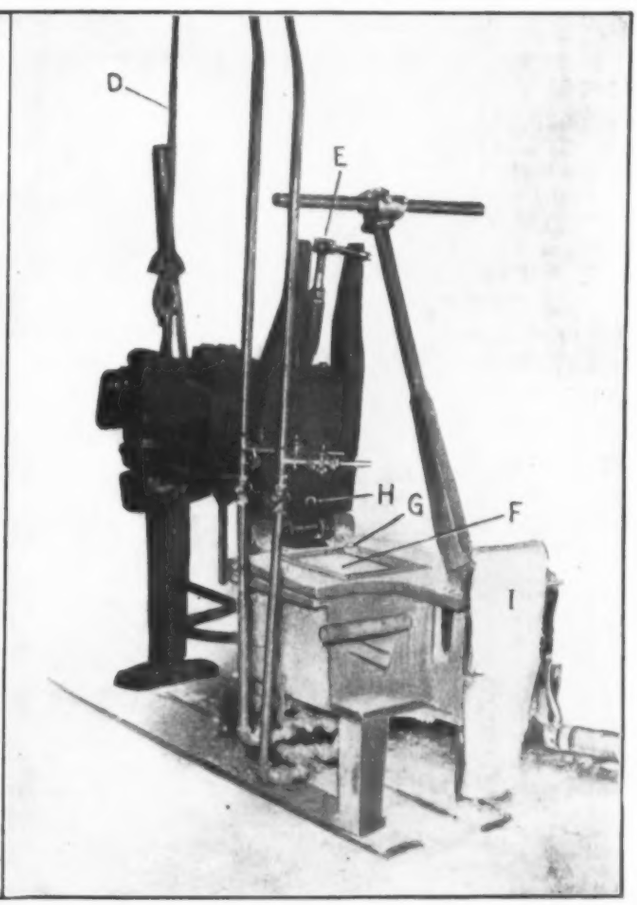


FIG. 2. GAGE THROWN BACK FOR REMOVAL OF CASTING

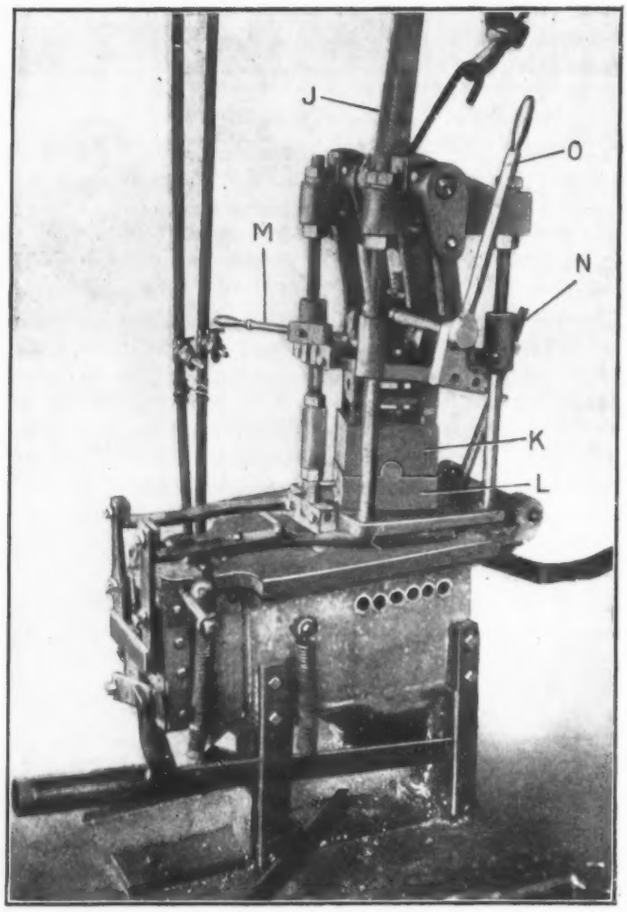


FIG. 3. DETAILS OF THE DIE CAGE

machine at *F*. The metal outlet is shown at *G* and the inlet to the die at *H*. When in the casting position this outlet and inlet fit snugly together and form a continuous passage to the die. In this view a piece of canvas *I* has been dropped over the latches to prevent any spray of metal striking the workman.

A machine with the feed lever removed is shown in Fig. 3. This view shows plainly the treadle and latch arrangement used to hold the cage down when in casting position. The toggle and lever *J* used to separate the parts *K* and *L* of the die are also plainly shown. The two die locks are shown at *M* and *N*. The lever *O* is used to operate the ejector pins of the die. The metal pots are heated by gas in the manner similar to that employed in other equipment of this nature.

The melting pots are so made as to be easily removed from the machines. Except for the boring out of the hole for the plunger and smoothing up of the end of the outlet, there is no machine work on them. One of the pots is shown in Fig. 4. These pots will hold from 60 to 65 lb. of metal. At *A* is a port $\frac{5}{8}$x2$\frac{1}{2}$ in., to let the melted metal run into the cylinder when the plunger is drawn back sufficiently. The plunger fitting this particular cylinder is shown at *B*; the end of the cylinder may be seen

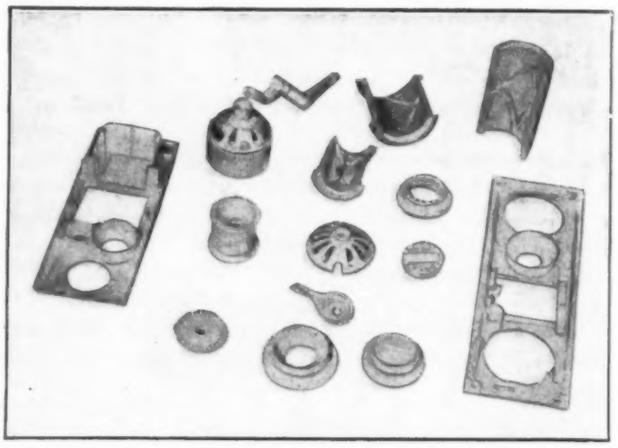


FIG. 6. EXAMPLES OF THE CASTINGS MADE

at *C*. It will be readily seen that with the cylinder full, pressing in of the plunger closes the port and forces the metal up through the opening *D* and into the die. When new, the plungers and bore of the cylinders are about 2 in. in diameter; but as the cylinder becomes worn or scored, it is rebored and a larger plunger used, until it becomes about 3$\frac{1}{2}$ in. in diameter, when it is scrapped. As the pots are interchangeable, the ones with the larger bores are used in the machines where the larger castings are made. The gates vary in size, according to the castings, from about $\frac{1}{2}$ to 1$\frac{1}{4}$ in. On the larger work the dies make only a single casting at a time, but where possible the dies are made double or multiple. As the "pulls" of an operator on a single machine will run from 800 to 1,000 per day, the output of a machine can be easily figured when the number made by a die is known.

A die for casting small motor shells is shown in Fig. 5. The levers for operating the core pins are shown at *A*, *B* and *C*. The lever *D* works a slide for the forming of a small boss on the side of the shell. The piece made is shown at *E*. This die is practically the same as that used in all die-casting machines and is typical.

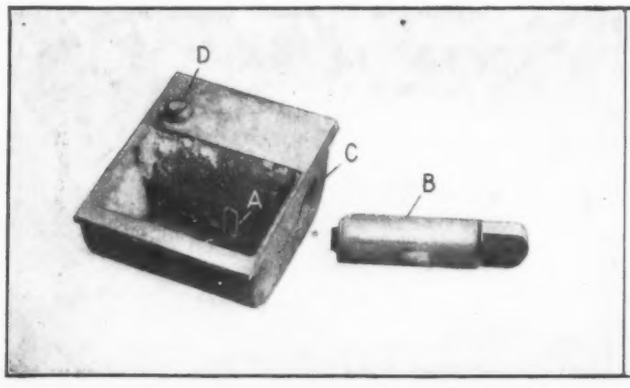


FIG. 4. THE MELTING POT AND PLUNGER

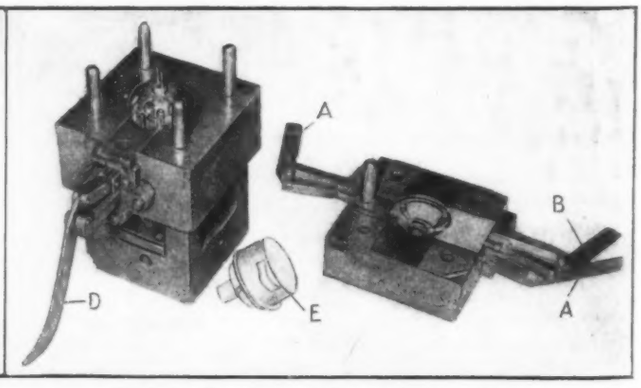


FIG. 5. DIE FOR SMALL MOTOR CASE

Engraving vs. Etching a Dial

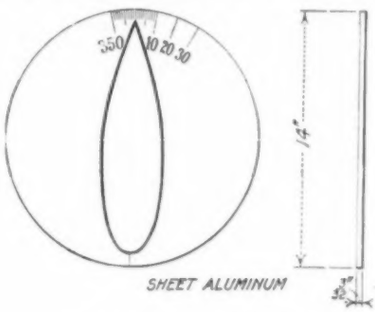
By William C. B. Richards

It was necessary to place the outline of a ship's deck on an aluminum dial about 14 in. in diameter and graduated in degrees on its outer edge with figures at every 10-deg. mark. The ship's deck in miniature was to be 12 in. long and 3 in. wide, as shown, with the outline itself $\frac{3}{16}$ in. wide.

The dial is used under glass because the entire instrument is required to withstand a submergency test of several hours in water at least 4 ft. deep. Therefore, every precaution must be taken to otherwise reduce reflectd lights, and inasmuch as the instrument is only used with open incandescent lights, great care is taken to diminish liability of error through wrong reading caused by reflection.

After cutting the dial, the graduations and figures are cut in on an engraving machine manually operated from interchangeable templets.

The dial, together with a blueprint of the ship's outline and centering dimensions, was then sent to a sign company which specialized in etched-metal work. This blueprint brought the bow of the ship to the zero mark in order to show the ship's heading with reference to the



DIAL FOR SHIP COMPASS

points of the compass. This was accomplished by having the dial electrically synchronized with a master gyro compass reading in degrees.

In the course of time these dials were returned enameled dull or dead black and baked. The graduations and figures were filled with dead white and the ship's outline was painted red, so that a red filler of the consistency of putty would adhere.

A peculiar condition developed here. Where the engraving had been done, the lines or edges of each cut were square and clean, allowing the white filler to be leveled off even with the dial face. This was found to be necessary, because if the filler fell below the dial surface, an edge of the cut would produce reflections. In the etched portion of the dial the edges were not only rough but undercut and the entire etched surface was of uneven depth. The latter fact was due to the acid being allowed to work too fast. This was determined by experiments made to find the cause of the time factor.

It developed early in these experiments that the sign company had to rush the etching process in order to make even a small profit, and it was further found that etching was out of the question for a particularly nice job. The metal seems to possess hard and soft spots, which are acted upon by the acid either by cutting very fast in the soft sections or slowly in the harder portions. Therefore in the filling of this etched line after painting it often happened that no filler at all would be left on the high spots, making a very unfinished appearance and producing the reflections.

It was found that our engraving machine reduced the figures traced from the templet as two to one and that a templet 24 in. long could be used. So we made up a templet of the ship's outline in this proportion—24 in. long and 6 in. wide—which would produce an outline of the desired size on the dial.

The templet was built up on a piece of flat brass with a thickness of $\frac{1}{8}$ in. and milled on a hand miller in suitable sections, then riveted to the baseplate to form a continuous raised templet. A $\frac{3}{16}$-in. diameter end mill was used in the engraving end of the machine, set to cut $\frac{1}{2}$ in. deep. The pointed end or extreme low of outline was finished with a fine engraving tool at the same setting of dial and templet.

It took the foreman on this job 30 min. to set up and a $12-a-week boy about 30 min. to complete the engraving. This was better time per piece than the etching process and gave us sharp, clean-cut edges, with square walls and an even under surface. This surface after painting took the red wax very smoothly, filling up to the original surface, and made a very fine-appearing dial, which won the instant approval of the naval inspector, who had been on the verge of rejecting the dials as originally delivered in the complete machine. Had this been the case, the time required to disassemble one of these instruments to the point where the dial could be taken out would have included the time of electrical testing and submergence, the same tests after assembly, together with a foreman instrument maker's time for 9½ hr., plus the attempt to retouch the dial by hand or the furnishing of a new dial. It therefore follows that the money saved in this instance more than paid for the investigation.

Calculation of Ratios for Gears

By Erik Wingquist

The method here described has its greatest usefulness in the calculation of gear ratios, the value of which cannot be expressed by whole—odd or even—numbers, or in cases in which one way or another may offer difficulties.

In ordinary cases the necessary gear ratios are found by a simple method shown by the following example:

To find ratio 5:8 with 4 gears, assume 2 gears with 40x30 teeth respectively—

$$\frac{30}{40} = \frac{3 \times 10}{4 \times 10}$$

It is easy to see that the number of teeth necessary in the numerator ought to be divisible by 5; and the corresponding number in the denominator ought to be $3 \times 2 = 6$. If one of the gears to be had, with a number of teeth divisible by 5, has 35 teeth, this number is placed in the numerator. The number of teeth of the fourth gear will then easily be found as follows:

$$\frac{35}{5} \cdot 2 \cdot 3 = 42,$$

and the result will be

$$\frac{30 \quad 35}{40 \times 42}$$

If the same method is tried for calculating a ratio of, for instance, 1:1.71, it takes a longer time to come to

Table of Ratios for Gear Trains

N.	Log. N.	N.	Log. N.	N.	Log. N.	N.	Log. N.	N.	Log. N.
100 : 30	0.5228787	85 : 33	0.4109050	69 : 30	0.3617278	78 : 37	0.3238929	96 : 49	0.2920751
99 : 30	0.5185139	90 : 35	0.4101745	85 : 37	0.3612172	99 : 47	0.3235373	94 : 48	0.2918867
98 : 30	0.5141048	95 : 37	0.4095219	78 : 34	0.3606157	80 : 38	0.3233064	92 : 47	0.2916899
97 : 30	0.5096504	77 : 30	0.4093694	94 : 41	0.3603440	82 : 39	0.3227493	90 : 46	0.2914847
100 : 31	0.5086383	100 : 39	0.4089354	71 : 31	0.3598966	84 : 40	0.3222193	88 : 45	0.2912702
96 : 30	0.5051499	82 : 32	0.4086639	87 : 38	0.3597357	63 : 30	0.3222192	86 : 44	0.2910458
99 : 31	0.5042735	87 : 34	0.4080404	80 : 35	0.3590220	86 : 41	0.3217146	84 : 43	0.2908108
95 : 30	0.5006023	92 : 36	0.4074853	96 : 42	0.3590219	65 : 31	0.3215517	82 : 42	0.2905646
98 : 31	0.4998644	97 : 38	0.4069881	89 : 39	0.3583254	88 : 42	0.3212334	80 : 41	0.2903061
94 : 30	0.4960066	79 : 31	0.4062654	73 : 32	0.3581729	67 : 32	0.3209248	78 : 40	0.2900346
97 : 31	0.4954100	84 : 33	0.4057654	98 : 43	0.3577576	90 : 43	0.3207740	76 : 39	0.2897490
100 : 32	0.4948500	89 : 35	0.4053220	82 : 36	0.3575114	69 : 33	0.3203352	74 : 38	0.2894481
93 : 30	0.4913616	94 : 37	0.4049262	91 : 40	0.3569814	92 : 44	0.3203351	72 : 37	0.2891308
96 : 31	0.4909095	99 : 39	0.4045706	75 : 33	0.3565474	94 : 45	0.3199154	70 : 36	0.2887955
99 : 32	0.4904852	76 : 30	0.4036923	100 : 44	0.3565473	71 : 34	0.3197794	68 : 35	0.2884409
92 : 30	0.4866665	81 : 32	0.4033350	84 : 37	0.3560776	96 : 46	0.3195134	66 : 34	0.2880650
95 : 31	0.4863619	86 : 34	0.4030196	93 : 41	0.3556990	73 : 35	0.3192549	99 : 51	0.2880650
98 : 32	0.4860761	91 : 36	0.4027389	68 : 30	0.3553876	98 : 47	0.3191282	97 : 50	0.2878017
91 : 30	0.4819201	96 : 38	0.4024876	77 : 34	0.3550118	100 : 48	0.3187588	64 : 33	0.2876661
94 : 31	0.4817662	78 : 31	0.4007329	86 : 38	0.3547149	75 : 36	0.3187588	95 : 49	0.2875275
97 : 32	0.4816217	83 : 33	0.4005642	95 : 42	0.3544743	77 : 37	0.3182890	93 : 48	0.2872417
100 : 33	0.4814861	88 : 35	0.4004147	70 : 31	0.3537363	79 : 38	0.3178435	62 : 32	0.2872417
99 : 33	0.4771213	93 : 37	0.4002812	79 : 35	0.3535591	81 : 39	0.3174204	91 : 47	0.2869435
96 : 32	0.4771212	98 : 39	0.4001615	88 : 39	0.3534181	83 : 40	0.3170181	60 : 31	0.2867896
93 : 31	0.4771212	100 : 40	0.3979400	97 : 43	0.3533032	85 : 41	0.3166350	89 : 46	0.2866322
90 : 30	0.4771212	95 : 38	0.3979400	99 : 44	0.3521825	87 : 42	0.3162700	87 : 45	0.2863068
98 : 33	0.4727122	90 : 36	0.3979400	90 : 40	0.3521825	89 : 43	0.3159215	58 : 30	0.2863067
95 : 32	0.4725736	85 : 34	0.3979400	81 : 36	0.3521825	91 : 44	0.3155887	85 : 44	0.2859662
92 : 31	0.4724261	80 : 32	0.3979400	72 : 32	0.3521825	93 : 45	0.3152704	83 : 43	0.2856096
89 : 30	0.4722687	75 : 30	0.3979400	92 : 41	0.3510039	62 : 30	0.3152704	81 : 42	0.2852357
100 : 34	0.4685211	97 : 39	0.3957071	83 : 37	0.3508764	95 : 46	0.3149658	79 : 41	0.2848432
97 : 33	0.4682578	92 : 37	0.3955861	74 : 33	0.3507178	64 : 31	0.3148183	77 : 40	0.2844307
94 : 32	0.4679779	87 : 35	0.3954513	94 : 42	0.3498786	97 : 47	0.3146738	75 : 39	0.2839967
91 : 31	0.4676797	82 : 33	0.3953000	85 : 38	0.3496353	99 : 48	0.3143940	100 : 52	0.2839967
88 : 30	0.4673614	77 : 31	0.3951290	76 : 34	0.3493347	66 : 32	0.3143939	98 : 51	0.2836559
99 : 34	0.4641563	99 : 40	0.3935752	67 : 30	0.3489535	68 : 33	0.3139950	73 : 38	0.2835393
96 : 33	0.4637573	94 : 38	0.3933443	96 : 43	0.3488027	70 : 34	0.3136191	96 : 50	0.2833012
93 : 32	0.4633329	89 : 36	0.3930875	87 : 39	0.3484547	72 : 35	0.3132645	71 : 37	0.2830566
90 : 31	0.4628808	84 : 34	0.3928004	78 : 35	0.3480266	74 : 36	0.3129292	94 : 49	0.2829318
87 : 30	0.4623980	79 : 32	0.3924771	98 : 44	0.3477734	76 : 37	0.3126119	92 : 48	0.2825466
98 : 34	0.4597472	74 : 30	0.3921104	69 : 31	0.3474874	78 : 38	0.3123110	69 : 36	0.2825466
95 : 33	0.4592097	96 : 39	0.3912066	89 : 40	0.3473300	80 : 39	0.3120254	90 : 47	0.2821446
92 : 32	0.4586378	91 : 37	0.3908397	100 : 45	0.3467875	82 : 40	0.3117539	67 : 35	0.2820068
89 : 31	0.4580283	86 : 35	0.3904305	80 : 36	0.3467875	84 : 41	0.3114954	88 : 46	0.2817249
86 : 30	0.4573772	81 : 33	0.3899711	91 : 41	0.3462575	86 : 42	0.3112492	65 : 34	0.2814345
100 : 35	0.4559320	76 : 31	0.3894519	71 : 32	0.3461083	88 : 43	0.3110142	86 : 45	0.2812860
97 : 34	0.4552928	98 : 40	0.3891661	82 : 37	0.3456122	90 : 44	0.3107898	84 : 44	0.2808266
94 : 33	0.4546140	93 : 38	0.3886993	93 : 42	0.3452336	92 : 45	0.3105753	63 : 33	0.2808266
91 : 32	0.4538914	88 : 36	0.3881802	73 : 33	0.3448090	94 : 46	0.3103701	82 : 43	0.2803451
88 : 31	0.4531210	83 : 34	0.3875992	84 : 38	0.3444957	96 : 47	0.3101733	61 : 32	0.2801798
85 : 30	0.4522976	100 : 41	0.3872161	95 : 43	0.3442551	98 : 48	0.3099849	80 : 42	0.2798407
99 : 35	0.4515672	78 : 32	0.3869446	75 : 34	0.3435824	100 : 49	0.3098039	99 : 52	0.2796319
96 : 34	0.4507923	95 : 39	0.3866590	86 : 39	0.3434339	61 : 30	0.3082085	59 : 31	0.2794903
93 : 33	0.4499690	73 : 30	0.3862016	97 : 44	0.3433190	63 : 31	0.3079788	78 : 41	0.2793107
90 : 32	0.4490925	90 : 37	0.3860408	88 : 40	0.3424227	65 : 32	0.3077634	97 : 51	0.2792015
87 : 31	0.4481576	85 : 35	0.3853509	77 : 35	0.3424227	67 : 33	0.3075609	95 : 50	0.2787536
98 : 35	0.4471581	97 : 40	0.3847117	99 : 45	0.3424227	69 : 34	0.3073702	57 : 30	0.2787536
84 : 30	0.4471580	80 : 33	0.3845761	66 : 30	0.3424226	71 : 35	0.3071903	76 : 40	0.2787536
95 : 34	0.4462447	92 : 38	0.3840042	90 : 41	0.3414586	73 : 36	0.3070204	93 : 49	0.2782868
92 : 33	0.4452739	75 : 31	0.3836996	79 : 36	0.3413246	75 : 37	0.3068596	74 : 39	0.2781671
89 : 32	0.4442400	87 : 36	0.3832168	68 : 31	0.3411472	77 : 38	0.3067071	91 : 48	0.2778002
100 : 36	0.4436975	99 : 41	0.3828513	92 : 42	0.3405385	79 : 39	0.3065625	72 : 38	0.2775489
86 : 31	0.4431368	82 : 34	0.3823350	81 : 37	0.3402833	81 : 40	0.3064250	89 : 47	0.2772921
97 : 35	0.4427037	94 : 39	0.3820633	70 : 32	0.3399480	83 : 41	0.3062942	70 : 37	0.2768963
83 : 30	0.4419568	77 : 32	0.3813407	94 : 43	0.3396594	85 : 42	0.3061696	87 : 46	0.2767615
94 : 34	0.4416490	89 : 37	0.3811883	83 : 38	0.3392945	87 : 43	0.3060508	68 : 36	0.2762064
91 : 33	0.4405275	84 : 35	0.3802113	72 : 33	0.3388186	89 : 44	0.3059373	85 : 45	0.2762064
99 : 36	0.4393327	96 : 40	0.3802112	96 : 44	0.3388185	91 : 45	0.3058289	100 : 53	0.2757241
88 : 32	0.4393327	72 : 30	0.3802112	85 : 39	0.3383543	93 : 46	0.3057251	83 : 44	0.2756254
96 : 35	0.4382032	91 : 38	0.3792578	98 : 45	0.3380136	95 : 47	0.3056257	66 : 35	0.2754759
85 : 31	0.4380572	79 : 33	0.3791132	74 : 34	0.3377528	97 : 48	0.3055305	98 : 52	0.2752228
93 : 34	0.4370040	98 : 41	0.3784422	87 : 40	0.3374593	99 : 49	0.3054591	81 : 43	0.2750165
82 : 30	0.4366926	86 : 36	0.3781960	100 : 46	0.3372422	100 : 50	0.3010300	96 : 51	0.2747010
90 : 33	0.4357286	74 : 31	0.3778709	76 : 35	0.3367456	98 : 49	0.3010300	64 : 34	0.2747011
98 : 36	0.4349236	93 : 39	0.3774183	89 : 41	0.3366061	96 : 48	0.3010300	79 : 42	0.2743778
87 : 32	0.4343693	81 : 34	0.3770061	91 : 42	0.3357921	94 : 47	0.3010300	94 : 50	0.2741579
95 : 35	0.4336556	100 : 42	0.3767507	78 : 36	0.3357921	92 : 46	0.3010300	62 : 33	0.2738778
84 : 31	0.4329176	88 : 37	0.3762810	65 : 30	0.3357921	94 : 45	0.3010300	77 : 41	0.2737068
92 : 34	0.4323089	95 : 40	0.3756636	93 : 43	0.3350144	88 : 44	0.3010300	92 : 49	0.2735917
100 : 37	0.4317983	76 : 32	0.3756636	80 : 37	0.3348883	86 : 43	0.3010300	90 : 48	0.2730013
81 : 30	0.4313637	83 : 35	0.3750101	67 : 31	0.3347131	87 : 42	0.3010300	75 : 40	0.2730013
89 : 33	0.4308761	90 : 38	0.3744589	95 : 44	0.3342709	82 : 41	0.3010300	60 : 32	0.2730013
97 : 36	0.4304692	71 : 30	0.3741370	82 : 38	0.3340303	80 : 40	0.3010300	88 : 47	0.2723848
86 : 32	0.4293485	97 : 41	0.3739878	69 : 32	0.3336991	78 : 39	0.3010300	73 : 39	0.2722583
94 : 35	0.4290599	78 : 33	0.3735807	97 : 45	0.3335592	76 : 38	0.3010300	58 : 31	0.2720663
83 : 31	0.4277164	85 : 36	0.3731164	84 : 39	0.3332147	74 : 37	0.3010300	86 : 46	0.2717407
91 : 34	0.4275625	92 : 39	0.3727232	99 : 46	0.3328774	72 : 36	0.3010300	71 : 38	0.2714747
99 : 37	0.4274335	99 : 42	0.3723859	71 : 33	0.3327444	70 : 35	0.3010300	99 : 53	0.2713593
88 : 33	0.4259688	73 : 31	0.3719612	86 : 40	0.3324385	68 : 34	0.3010300	84 : 45	0.2710668
96 : 36	0.4259687	80 : 34	0.3716111	73 : 34	0.3318440	66 : 33	0.3010300	56 : 30	0.2710667
80 : 30	0.4259687	87 : 37	0.3713176	88 : 41	0.3316988	64 : 32	0.3010300	97 : 52	0.2707684
93 : 35	0.4244149	94 : 40	0.3710679	75 : 35	0.3309933	62 : 31	0.3010300	69 : 37	0.2706474
85 : 32	0.4242689	75 : 32	0.3699113	90 : 42	0.3309932	60 : 30	0.3010300	82 : 44	0.2703612
98 : 37	0.4230244	82 : 35	0.3697459	92 : 43	0.3303193	99 : 50	0.2966652	95 : 51	0.2701534
90 : 34	0.4227636	89 : 38	0.3696064	77 : 36	0.3301882	97 : 49	0.2965756	67 : 36	0.2697723
82 : 31	0.4224522	96 : 41	0.3694873	94 : 44	0.3296752	95 : 48	0.2964824	80 : 43	0.2696215
95 : 36	0.4214211	98 : 42	0.3679768	73 : 37	0.3294254	93 : 47	0.2963850	93 : 50	0.2695129
87 : 33	0.4210054	91 : 39	0.3679768	96 : 45	0.3290587	91 : 46	0.2962836	65 : 35	0.2688454
79 : 30	0.4205058	84 : 36	0.3679768	64 : 30	0.3290587	89 : 45	0.2961775	91 : 49	0.2688453
100 : 38	0.4202164	77 : 33	0.3679768	81 : 38	0.3287014	87 : 44	0.2960666	78 : 42	0.2688453
92 : 35	0.4197198	70 : 30	0.3679767	98 : 46	0.3284683	85 : 43	0.2959504	89 : 48	0.2681488
84 : 32	0.4191293	100 : 43	0.3665315	66 : 31	0.3281822	83 : 42	0.2958288	76 : 41	0.2680297
97 : 37	0.4185700	93 : 40	0.3664229	83 : 39	0.3280135	81 : 41	0.2957011	63 : 34	0.2678616
89 : 34	0.4179111	86 : 37	0.3662968	100 : 47	0.3279021	79 : 40	0.2955671	100 : 54	0.2676062
81 : 31	0.4171233	79 : 34	0.3661482	85 : 40	0.3273589	77 : 39	0.2954261	87 : 47	0.2674214
94 : 36	0.4168254	72 : 31	0.3659708	68 : 32	0.3273589	75 : 38	0.2952777	74 : 40	0.2671717
86 : 33	0.4159846	95 : 41	0.3649397	87 : 41	0.3267354	73 : 37	0.2951212	98 : 53	0.2669502
99 : 38	0.4158516	88 : 38	0.3646991	70 : 33	0.3265841	71 : 36	0.2949558	61 : 33	0.2668159
91 : 35	0.4149734	81 : 35	0.3644170	89 : 42	0.3261407	69 : 35	0.2947811	85 : 46	0.2666611
78 : 30	0.4149733	74 : 32	0.3640817	72 : 34	0.3258536	67 : 34	0.2945959	96 : 52	0.2662679
96 : 37	0.4140695	97 : 42	0.3635224	91 : 43	0.3255729	65 : 33	0.2943995	72 : 39	0.2662679
83 : 32	0.4139281	90 : 39	0.3631779	74 : 35	0.3251637	63 : 32	0.2941905	83 : 45	0.2658656
88 : 34	0.4130038	83 : 36	0.3627756	93 : 44	0.3250302	61 : 31	0.2939681	59 : 32	0.2657020
93 : 36	0.4121804	76 : 33	0.3622997	95 : 45	0.3245111	59 : 30	0.2937307	94 : 51	0.2655577
80 : 31	0.4117283	99 : 43	0.3621667	76 : 36	0.3245111	100 : 51	0.2924298	70 : 38	0.2653144
98 : 38	0.4114425	92 : 40	0.3617278	97 : 46	0.3240139	98 : 50	0.2922561	81 : 44	0.2650323

TABLE OF RATIOS FOR GEAR TRAINS—Continued

N.	Log. N.	N.	Log. N.	N.	Log. N.	N.	Log. N.	N.	Log. N.
92 : 50	0.2648178	99 : 57	0.2397603	94 : 57	0.2172530	88 : 56	0.1962947	78 : 52	0.1760913
57 : 31	0.2645132	66 : 38	0.2397603	61 : 37	0.2171281	55 : 35	0.1962947	75 : 50	0.1760913
68 : 37	0.2643072	92 : 53	0.2395119	89 : 54	0.2169962	77 : 49	0.1962946	72 : 48	0.1760913
79 : 43	0.2641586	59 : 34	0.2393731	84 : 51	0.2167091	66 : 42	0.1962946	69 : 46	0.1760913
90 : 49	0.2640464	85 : 49	0.2392228	56 : 34	0.2167091	91 : 58	0.1956134	60 : 40	0.1760913
88 : 48	0.2632415	78 : 45	0.2388821	79 : 48	0.2163859	80 : 51	0.1955198	57 : 38	0.1760913
99 : 54	0.2632414	52 : 30	0.2388820	51 : 31	0.2162085	69 : 44	0.1953964	54 : 36	0.1760913
77 : 42	0.2632414	97 : 56	0.2385837	74 : 45	0.2160192	58 : 37	0.1952263	51 : 34	0.1760913
66 : 36	0.2632414	71 : 41	0.2388744	97 : 59	0.2159197	94 : 60	0.1949766	96 : 64	0.1760912
55 : 30	0.2632414	90 : 52	0.2382392	92 : 56	0.2155998	47 : 30	0.1949766	93 : 62	0.1760912
97 : 53	0.2624958	64 : 37	0.2379783	69 : 42	0.2155998	83 : 53	0.1948022	90 : 60	0.1760912
86 : 47	0.2624006	83 : 48	0.2378369	87 : 53	0.2152434	72 : 46	0.1945747	81 : 54	0.1760912
75 : 41	0.2622774	57 : 33	0.2373610	64 : 39	0.2151154	97 : 62	0.1943800	66 : 44	0.1760912
64 : 35	0.2621120	95 : 55	0.2373609	82 : 50	0.2148439	61 : 39	0.1942652	63 : 42	0.1760912
95 : 52	0.2617203	76 : 44	0.2373609	100 : 61	0.2146702	86 : 55	0.1941358	48 : 32	0.1760912
84 : 46	0.2615215	88 : 51	0.2369125	59 : 36	0.2145495	75 : 48	0.1938201	45 : 30	0.1760912
73 : 40	0.2612629	69 : 40	0.2367891	77 : 47	0.2143928	100 : 64	0.1938200	100 : 67	0.1739252
62 : 34	0.2609128	100 : 58	0.2365720	95 : 58	0.2142956	50 : 32	0.1938200	97 : 65	0.1738583
93 : 51	0.2609127	81 : 47	0.2363871	54 : 33	0.2138799	89 : 57	0.1935151	94 : 63	0.1737874
82 : 45	0.2606014	62 : 36	0.2360892	90 : 55	0.2138798	64 : 41	0.1933961	91 : 61	0.1737116
71 : 39	0.2601937	93 : 54	0.2360891	72 : 44	0.2138798	78 : 50	0.1931246	88 : 59	0.1736307
91 : 50	0.2600714	74 : 43	0.2357632	85 : 52	0.2134156	92 : 59	0.1929358	85 : 57	0.1735440
60 : 33	0.2596374	86 : 50	0.2355285	67 : 41	0.2139409	53 : 34	0.1927970	82 : 55	0.1734512
100 : 55	0.2596373	98 : 57	0.2353512	98 : 60	0.2130748	67 : 43	0.1926063	79 : 53	0.1733512
80 : 44	0.2596373	55 : 32	0.2352127	49 : 30	0.2130748	81 : 52	0.1924817	76 : 51	0.1732434
89 : 49	0.2591939	67 : 39	0.2350102	80 : 49	0.2128939	95 : 61	0.1923938	73 : 49	0.1731268
59 : 38	0.2590655	79 : 46	0.2348693	62 : 38	0.2126081	98 : 63	0.1918856	70 : 47	0.1730001
98 : 54	0.2588323	91 : 53	0.2347655	93 : 57	0.2126080	84 : 54	0.1918855	67 : 45	0.1728623
78 : 43	0.2586261	60 : 35	0.2340833	75 : 46	0.2123035	70 : 45	0.1918855	64 : 43	0.1727115
87 : 48	0.2582781	96 : 56	0.2340832	88 : 54	0.2120889	56 : 36	0.1918855	61 : 41	0.1725459
58 : 32	0.2582780	84 : 49	0.2340832	57 : 35	0.2118069	87 : 56	0.1913313	58 : 39	0.1723634
96 : 53	0.2579953	72 : 42	0.2340832	70 : 43	0.2116295	73 : 47	0.1912250	55 : 37	0.1721610
67 : 37	0.2578731	89 : 52	0.2333867	83 : 51	0.2115079	59 : 38	0.1910684	52 : 35	0.1719353
76 : 42	0.2575643	77 : 45	0.2332782	96 : 59	0.2114192	90 : 58	0.1908145	98 : 66	0.1716822
85 : 47	0.2573210	65 : 38	0.2331298	91 : 56	0.2108534	76 : 49	0.1906175	49 : 33	0.1716822
94 : 52	0.2571246	53 : 31	0.2329142	78 : 48	0.2108534	62 : 40	0.1903317	95 : 64	0.1715436
56 : 31	0.2568263	94 : 55	0.2327652	65 : 40	0.2108534	93 : 60	0.1903316	92 : 62	0.1713961
65 : 36	0.2566109	82 : 48	0.2325727	52 : 32	0.2108533	79 : 51	0.1900569	46 : 31	0.1713961
74 : 41	0.2564478	70 : 41	0.2323141	99 : 61	0.2103054	96 : 62	0.1898795	89 : 60	0.1712387
83 : 46	0.2563203	99 : 58	0.2329072	86 : 53	0.2102226	48 : 31	0.1898795	86 : 58	0.1710705
92 : 51	0.2562176	87 : 51	0.2319491	73 : 45	0.2101104	65 : 42	0.1896641	83 : 56	0.1708401
99 : 55	0.2552725	58 : 34	0.2319491	60 : 37	0.2099496	82 : 53	0.1895380	80 : 54	0.1706962
90 : 50	0.2552725	75 : 44	0.2316086	94 : 58	0.2096999	99 : 64	0.1894552	77 : 52	0.1704874
81 : 45	0.2552725	92 : 54	0.2313940	81 : 50	0.2095150	51 : 33	0.1890563	74 : 50	0.1702617
72 : 40	0.2552725	63 : 37	0.2311388	68 : 42	0.2092596	85 : 55	0.1890562	71 : 48	0.1700171
63 : 35	0.2552725	80 : 47	0.2309921	89 : 55	0.2090273	68 : 44	0.1890562	68 : 46	0.1697511
54 : 30	0.2552725	97 : 57	0.2308968	55 : 34	0.2088838	88 : 57	0.1886078	99 : 67	0.1695604
97 : 54	0.2543779	51 : 30	0.2304489	76 : 47	0.2087157	71 : 46	0.1885005	65 : 44	0.1694607
88 : 49	0.2542866	85 : 50	0.2304489	97 : 60	0.2086204	54 : 35	0.1883258	96 : 65	0.1693578
79 : 44	0.2541744	68 : 40	0.2304489	84 : 52	0.2082760	91 : 59	0.1881894	93 : 63	0.1691424
70 : 39	0.2540334	90 : 53	0.2299666	63 : 39	0.2082759	74 : 48	0.1879905	62 : 42	0.1691424
61 : 34	0.2538509	73 : 43	0.2294544	92 : 57	0.2079129	94 : 61	0.1877981	90 : 61	0.1689127
95 : 53	0.2534477	56 : 33	0.2296741	71 : 44	0.2078056	57 : 37	0.1876732	59 : 40	0.1687920
86 : 48	0.2532573	95 : 56	0.2295356	100 : 62	0.2076083	77 : 50	0.1875207	87 : 59	0.1686673
77 : 43	0.2530222	78 : 46	0.2293368	50 : 31	0.2076083	97 : 63	0.1874312	84 : 57	0.1684044
68 : 38	0.2527253	100 : 59	0.2291480	79 : 49	0.2074310	80 : 52	0.1870867	56 : 38	0.1684044
93 : 52	0.2524796	61 : 36	0.2290273	87 : 51	0.2071255	60 : 39	0.1870867	81 : 55	0.1681223
59 : 33	0.2523381	83 : 49	0.2288820	58 : 36	0.2071255	100 : 65	0.1870866	53 : 36	0.1679734
84 : 47	0.2521814	88 : 52	0.2284794	95 : 59	0.2068716	83 : 54	0.1866843	78 : 53	0.1678187
100 : 56	0.2518120	66 : 39	0.2284793	66 : 41	0.2067600	63 : 41	0.1865566	100 : 68	0.1674911
75 : 42	0.2518120	93 : 55	0.2281202	74 : 46	0.2064739	86 : 56	0.1863105	75 : 51	0.1674911
91 : 51	0.2514712	71 : 42	0.2280090	82 : 57	0.2062437	66 : 43	0.1860754	50 : 34	0.1674911
66 : 37	0.2513422	98 : 55	0.2277981	90 : 56	0.2060545	89 : 58	0.1859620	97 : 66	0.1672278
82 : 46	0.2510561	76 : 45	0.2276011	98 : 61	0.2058963	69 : 45	0.1856366	72 : 49	0.1671364
98 : 55	0.2508634	81 : 48	0.2272438	53 : 33	0.2057620	92 : 60	0.1856365	47 : 32	0.1669479
57 : 32	0.2507249	54 : 32	0.2272438	61 : 38	0.2055462	46 : 30	0.1856365	94 : 64	0.1669479
73 : 41	0.2505390	86 : 51	0.2269283	69 : 43	0.2053806	95 : 62	0.1853319	69 : 47	0.1667512
89 : 50	0.2504200	59 : 35	0.2267840	77 : 48	0.2052495	72 : 47	0.1852346	91 : 62	0.1666497
80 : 45	0.2498775	91 : 54	0.2266476	85 : 53	0.2051430	98 : 64	0.1850461	88 : 60	0.1663314
64 : 36	0.2498775	64 : 38	0.2263964	93 : 58	0.2050549	49 : 32	0.1850461	66 : 45	0.1663314
96 : 54	0.2498774	96 : 57	0.2263963	88 : 55	0.2041200	75 : 49	0.1848652	44 : 30	0.1663314
87 : 49	0.2493232	69 : 41	0.2260652	80 : 50	0.2041200	78 : 51	0.1845244	85 : 58	0.1679909
71 : 40	0.2491983	74 : 44	0.2257790	72 : 45	0.2041200	52 : 34	0.1845244	63 : 43	0.1658720
55 : 31	0.2490010	79 : 47	0.2255292	64 : 40	0.2041200	81 : 53	0.1842091	82 : 56	0.1656259
94 : 53	0.2488520	84 : 50	0.2253093	56 : 35	0.2041200	55 : 36	0.1840602	60 : 41	0.1653674
78 : 44	0.2486419	89 : 53	0.2251141	96 : 60	0.2041199	84 : 55	0.1839166	79 : 54	0.1652333
62 : 35	0.2483237	94 : 56	0.2249399	48 : 30	0.2041199	87 : 57	0.1836444	98 : 67	0.1651513
85 : 48	0.2481777	99 : 59	0.2247832	99 : 62	0.2032435	58 : 38	0.1836444	76 : 52	0.1648103
92 : 52	0.2477845	52 : 31	0.2246416	91 : 57	0.2031665	90 : 59	0.1833905	57 : 39	0.1648103
69 : 39	0.2477845	57 : 34	0.2243960	83 : 52	0.2030748	61 : 40	0.1832698	95 : 65	0.1648102
99 : 56	0.2474472	62 : 37	0.2241900	75 : 47	0.2029634	93 : 61	0.1831531	92 : 63	0.1644473
76 : 43	0.2473451	67 : 40	0.2240148	67 : 42	0.2028255	96 : 63	0.1829307	73 : 50	0.1643529
53 : 30	0.2471546	72 : 43	0.2238640	59 : 37	0.2026503	64 : 42	0.1829307	54 : 37	0.1641921
83 : 47	0.2469802	77 : 46	0.2237329	51 : 32	0.2024202	99 : 65	0.1827218	89 : 61	0.1640602
60 : 34	0.2466724	82 : 49	0.2236178	94 : 59	0.2022759	67 : 44	0.1826221	70 : 48	0.1638568
90 : 51	0.2466723	87 : 52	0.2235160	86 : 54	0.2021047	70 : 46	0.1823402	86 : 59	0.1636465
97 : 55	0.2464090	92 : 55	0.2234251	78 : 49	0.2018985	73 : 48	0.1820817	51 : 35	0.1635022
67 : 38	0.2462912	97 : 58	0.2233437	70 : 44	0.2016453	76 : 50	0.1818436	67 : 46	0.1633170
74 : 42	0.2459824	80 : 48	0.2218488	97 : 61	0.2014419	79 : 52	0.1816238	83 : 57	0.1632032
81 : 46	0.2457272	75 : 45	0.2218488	62 : 39	0.2013271	82 : 54	0.1814201	99 : 68	0.1631263
88 : 50	0.2455127	65 : 39	0.2218488	89 : 56	0.2012020	85 : 56	0.1812309	96 : 66	0.1627273
95 : 54	0.2453298	60 : 36	0.2218488	54 : 34	0.2009149	88 : 58	0.1810547	80 : 55	0.1627273
58 : 33	0.2449141	55 : 33	0.2218488	81 : 51	0.2009148	91 : 60	0.1808901	64 : 44	0.1627273
65 : 37	0.2447117	100 : 60	0.2218487	100 : 63	0.2006595	94 : 62	0.1807362	48 : 33	0.1627273
72 : 41	0.2445486	95 : 57	0.2218487	73 : 46	0.2005651	47 : 31	0.1807362	93 : 64	0.1623029
79 : 45	0.2444146	90 : 54	0.2218487	92 : 58	0.2003598	97 : 64	0.1805917	77 : 53	0.1622148
86 : 49	0.2443024	85 : 51	0.2218487	65 : 41	0.2001295	50 : 33	0.1804561	61 : 42	0.1620805
93 : 53	0.2442070	70 : 42	0.2218487	84 : 53	0.2000034	100 : 66	0.1804561	90 : 62	0.1618508
100 : 57	0.2441251	50 : 30	0.2218487	76 : 48	0.1995724	53 : 35	0.1802079	45 : 31	0.1618508
98 : 56	0.2430381	98 : 59	0.2203741	57 : 36	0.1995724	56 : 37	0.1799863	74 : 51	0.1616615
91 : 52	0.2430381	93 : 56	0.2204949	95 : 60	0.1995723	59 : 39	0.1797874	87 : 60	0.1613680
81 : 48	0.2430381	88 : 53	0.2202068	87 : 55	0.1991566	62 : 41	0.1796078	58 : 40	0.1613680
77 : 44	0.2430380	83 : 50	0.2201081	68 : 43	0.1990404	65 : 43	0.1794449	100 : 69	0.1611509
70 : 40	0.2430380	78 : 47	0.2199967	98 : 62	0.1988344	68 : 45	0.1792964	71 : 49	0.1610622
63 : 36	0.2430380	68 : 41	0.2197250	49 : 31	0.1988344	71 : 47	0.1791604	84 : 58	0.1608513
56 : 32	0.2430380	73 : 44	0.2198702	79 : 50	0.1986571	74 : 49	0.1790356	97 : 67	0.1606969
96 : 55	0.2419085	63 : 38	0.2195569	60 : 38	0.1983677	77 : 51	0.1789205	55 : 38	0.1605791
89 : 51	0.2418198	58 : 35	0.2193600	90 : 57	0.1983676	80 : 53	0.1788141	68 : 47	0.1604110
82 : 47	0.2417160	53 : 32	0.2191259	71 : 45	0.1980458	83 : 55	0.1787154	81 : 56	0.1602970
75 : 43	0.2415928	96 : 58	0.2188432	82 : 52	0.1978106	86 : 57	0.1786236	94 : 65	0.1602145
68 : 39	0.2414443	91 : 55	0.2186787	93 : 59	0.1976309	89 : 59	0.1785380	91 : 63	0.1597009
61 : 35	0.2412618	86 : 52	0.2184952	52 : 33	0.1974894	92 : 61	0.1784580	65 : 45	0.1597009
54 : 31	0.2410321	81 : 49	0.2182889	63 : 40	0.1972805	95 : 63	0.1783831	78 : 54	0.1597008
94 : 54	0.2407341	76 : 46	0.2180558	74 : 47	0.1971338	98 : 65	0.1783127	52 : 36	0.1597008
87 : 50	0.2405493	71 : 43	0.2177398	85 : 54	0.1970251	99 : 66	0.1760913	88 : 61	0.1591529
80 : 46	0.2403322	99 : 60	0.2174839	96 : 61	0.1969414	87 : 58	0.1760913	75 : 52	0.1590580
73 : 42	0.2400736	66 : 40	0.2174839	99 : 63	0.1962947	84 : 56	0.1760913	62 : 43	0.1589232

TABLE OF RATIOS FOR GEAR TRAINS—Continued

N.	Log. N.	N.	Log. N.	N.	Log. N.	N.	Log. N.	N.	Log. N.
98 : 68	0.1587172	79 : 57	0.1417522	44 : 33	0.1249388	76 : 59	0.1099616	61 : 49	0.0951337
49 : 34	0.1587172	97 : 70	0.1416737	100 : 75	0.1249387	85 : 66	0.1098750	56 : 45	0.0949755
85 : 59	0.1585669	72 : 52	0.1413292	96 : 72	0.1249387	94 : 73	0.1098050	51 : 41	0.0947863
72 : 50	0.1583625	54 : 39	0.1413292	92 . 69	0.1249387	63 : 49	0.1091444	97 : 78	0.0946771
95 : 66	0.1581797	90 : 65	0.1413291	80 : 60	0.1249387	99 : 77	0.1091445	92 : 74	0.0945561
59 : 41	0.1580681	83 : 60	0.1409268	76 : 57	0.1249387	90 : 70	0.1091445	46 : 37	0.0945561
82 : 57	0.1579390	65 : 47	0.1408155	72 : 54	0.1249387	81 : 63	0.1091445	87 : 70	0.0944213
69 : 48	0.1576079	94 : 68	0.1406190	68 : 51	0.1249387	72 : 56	0.1091445	82 : 66	0.0942700
92 : 64	0.1576078	47 : 34	0.1406190	56 : 42	0.1249387	54 : 42	0.1091445	41 : 33	0.0942700
46 : 32	0.1576078	76 : 55	0.1404509	52 : 39	0.1249387	45 : 35	0.1091445	77 : 62	0.0940990
79 : 55	0.1572644	87 : 63	0.1401788	40 : 30	0.1249387	95 : 74	0.1084919	72 : 58	0.0939045
56 : 39	0.1571234	58 : 42	0.1401787	48 : 36	0.1249387	86 : 67	0.1084237	67 : 54	0.0936810
89 : 62	0.1569983	98 : 71	0.1399678	97 : 73	0.1234488	77 : 60	0.1083394	98 : 79	0.0935990
99 : 69	0.1567861	69 : 50	0.1398791	93 : 70	0.1233849	68 : 53	0.1082330	62 : 50	0.0934217
66 : 46	0.1567861	80 : 58	0.1396620	89 : 67	0.1233152	59 : 46	0.1080942	93 : 75	0.0934216
76 : 53	0.1565377	91 : 66	0.1394975	85 : 64	0.1232389	100 : 78	0.1079054	88 : 71	0.0932244
86 : 60	0.1563472	51 : 37	0.1393685	81 : 61	0.1231552	50 : 39	0.1079054	57 : 46	0.0931171
43 : 30	0.1563472	62 : 45	0.1391792	77 : 58	0.1230627	91 : 71	0.1077831	83 : 67	0.0930033
96 : 67	0.1561964	73 : 53	0.1390470	73 : 55	0.1229602	82 : 64	0.1076339	78 : 63	0.0927541
53 : 37	0.1560742	84 : 61	0.1389495	69 : 52	0.1228458	41 : 32	0.1076339	52 : 42	0.0927540
63 : 44	0.1558878	95 : 69	0.1388745	65 : 49	0.1227173	73 : 57	0.1074480	99 : 80	0.0925452
73 : 51	0.1557527	99 : 72	0.1383027	61 : 46	0.1225720	64 : 50	0.1072100	73 : 59	0.0924709
83 : 58	0.1556501	88 : 64	0.1383027	57 : 43	0.1224064	96 : 75	0.1072099	94 : 76	0.0923143
93 : 65	0.1555695	77 : 56	0.1383027	53 : 40	0.1222159	87 : 68	0.1070104	47 : 38	0.0923143
90 : 63	0.1549020	66 : 48	0.1383027	98 : 74	0.1219944	55 : 43	0.1068942	68 : 55	0.0921462
80 : 56	0.1549020	55 : 40	0.1383027	49 : 37	0.1219944	78 : 61	0.1067648	89 : 72	0.0920575
60 : 42	0.1549020	44 : 32	0.1383027	94 : 71	0.1218696	92 : 72	0.1064553	84 : 68	0.0917704
50 : 35	0.1549020	92 : 67	0.1377130	90 : 68	0.1217336	69 : 54	0.1064553	42 : 34	0.0917704
100 : 70	0.1549020	81 : 59	0.1376330	45 : 34	0.1217336	46 : 36	0.1064553	63 : 51	0.0917703
70 : 49	0.1549019	70 : 51	0.1375278	86 : 65	0.1215851	83 : 65	0.1061647	100 : 81	0.0915150
97 : 68	0.1542628	59 : 43	0.1373835	82 : 62	0.1214222	60 : 47	0.1060534	79 : 64	0.0914471
87 : 61	0.1541895	48 : 35	0.1371732	41 : 31	0.1214222	97 : 76	0.1059581	58 : 47	0.0913301
77 : 54	0.1540969	96 : 70	0.1371732	78 : 59	0.1212426	74 : 58	0.1058037	95 : 77	0.0912329
67 : 47	0.1539769	85 : 62	0.1370272	74 : 56	0.1210437	88 : 69	0.1056336	74 : 60	0.0910804
57 : 40	0.1538149	74 : 54	0.1368379	70 : 53	0.1208221	51 : 40	0.1055702	37 : 30	0.0910804
94 : 66	0.1535840	100 : 73	0.1366771	99 : 75	0.1205739	65 : 51	0.1053432	90 : 73	0.0909196
47 : 33	0.1535840	63 : 46	0.1365827	66 : 50	0.1205739	79 : 62	0.1052354	53 : 43	0.0908074
84 : 59	0.1534273	89 : 65	0.1364766	95 : 72	0.1203911	93 : 73	0.1051600	69 : 56	0.0906611
74 : 52	0.1532284	78 : 57	0.1362197	62 : 47	0.1202938	98 : 77	0.1047354	85 : 69	0.0905698
64 : 45	0.1529675	52 : 38	0.1362197	91 : 69	0.1201923	84 : 66	0.1047354	64 : 52	0.0901767
91 : 64	0.1528614	93 : 68	0.1359740	87 : 66	0.1199754	42 : 33	0.1047354	96 : 78	0.0901766
54 : 38	0.1526102	67 : 49	0.1358787	58 : 44	0.1199753	70 : 55	0.1047353	80 : 65	0.0901766
81 : 57	0.1526101	82 : 60	0.1356626	83 : 63	0.1197376	56 : 44	0.1047353	48 : 39	0.0901766
98 : 69	0.1523770	41 : 30	0.1356626	54 : 41	0.1196099	89 : 70	0.1042920	91 : 74	0.0898097
71 : 50	0.1522883	97 : 71	0.1355134	79 : 60	0.1194758	75 : 59	0.1042093	75 : 61	0.0897315
88 : 62	0.1520910	56 : 41	0.1354041	100 : 76	0.1191864	61 : 48	0.1040886	59 : 48	0.0896108
44 : 31	0.1520910	71 : 52	0.1352550	75 : 57	0.1191864	94 : 74	0.1038962	86 : 70	0.0894005
61 : 43	0.1518613	86 : 63	0.1351580	50 : 38	0.1191864	47 : 37	0.1038962	43 : 35	0.0894005
78 : 55	0.1517314	90 : 66	0.1346986	96 : 73	0.1189483	80 : 63	0.1037495	70 : 57	0.0892231
95 : 67	0.1516488	75 : 55	0.1346986	71 : 54	0.1188645	99 : 78	0.1035406	97 : 79	0.0891446
68 : 48	0.1512677	60 : 44	0.1346986	92 : 70	0.1186898	66 : 52	0.1035406	81 : 66	0.0889411
51 : 36	0.1512677	45 : 33	0.1346986	46 : 35	0.1186898	85 : 67	0.1033441	54 : 44	0.0889411
85 : 60	0.1512676	94 : 69	0.1342788	67 : 51	0.1185046	52 : 41	0.1032194	92 : 75	0.0887265
92 : 65	0.1508744	79 : 58	0.1341991	88 : 67	0.1184079	71 : 56	0.1030703	65 : 53	0.0886375
75 : 53	0.1507854	64 : 47	0.1340821	84 : 64	0.1180993	90 : 71	0.1029842	76 : 62	0.0884219
58 : 41	0.1506441	98 : 72	0.1338936	63 : 48	0.1180993	57 : 45	0.1026624	38 : 31	0.0884219
99 : 70	0.1505372	49 : 36	0.1338936	42 : 32	0.1180993	95 : 75	0.1026623	87 : 71	0.0882610
82 : 58	0.1503859	83 : 61	0.1337483	80 : 61	0.1177602	76 : 60	0.1026623	98 : 80	0.0881361
65 : 46	0.1501556	68 : 50	0.1335389	59 : 45	0.1176395	38 : 30	0.1026623	49 : 40	0.0881361
89 : 63	0.1500495	87 : 64	0.1333393	97 : 74	0.1175400	100 : 79	0.1023729	60 : 49	0.0879552
96 : 68	0.1497623	53 : 39	0.1332113	76 : 58	0.1173856	81 : 64	0.1023050	71 : 58	0.0878303
72 : 51	0.1497623	72 : 53	0.1330566	93 : 71	0.1172246	62 : 49	0.1021956	82 : 67	0.0877391
48 : 34	0.1497623	91 : 67	0.1329666	55 : 42	0.1171134	86 : 68	0.1019896	93 : 76	0.0876693
79 : 56	0.1494391	95 : 70	0.1326256	72 : 55	0.1169698	43 : 34	0.1019896	99 : 81	0.0871502
55 : 39	0.1492981	76 : 56	0.1326256	89 : 68	0.1168811	67 : 53	0.1017989	88 : 72	0.0871502
86 : 61	0.1491687	57 : 42	0.1326256	68 : 52	0.1165056	91 : 72	0.1017089	77 : 63	0.0871502
93 : 66	0.1489390	99 : 73	0.1323123	51 : 39	0.1165056	96 : 76	0.1014576	55 : 45	0.0871502
62 : 44	0.1489390	80 : 59	0.1322380	85 : 65	0.1165055	72 : 57	0.1014576	44 : 36	0.0871502
100 : 71	0.1487417	61 : 45	0.1321173	98 : 75	0.1161648	48 : 38	0.1014576	66 : 54	0.0871501
69 : 49	0.1486530	84 : 62	0.1318876	81 : 62	0.1160933	77 : 61	0.1011609	94 : 77	0.0866372
76 : 54	0.1484198	42 : 31	0.1318876	64 : 49	0.1159839	53 : 42	0.1010266	83 : 68	0.0865692
83 : 59	0.1482261	65 : 48	0.1316722	94 : 72	0.1157954	82 : 65	0.1009005	72 : 59	0.0864805
90 : 64	0.1480625	88 : 65	0.1315693	47 : 36	0.1157954	87 : 69	0.1006702	61 : 50	0.0863598
45 : 32	0.1480625	92 : 68	0.1312789	77 : 59	0.1156387	58 : 46	0.1006702	100 : 82	0.0861861
97 : 69	0.1479226	69 : 51	0.1312789	60 : 46	0.1153935	92 : 73	0.1004649	50 : 41	0.0861861
52 : 37	0.1478016	46 : 34	0.1312789	90 : 69	0.1153934	63 : 50	0.1003705	89 : 73	0.0860671
59 : 42	0.1476027	96 : 71	0.1310129	73 : 56	0.1151349	97 : 77	0.1002810	78 : 64	0.0859146
66 : 47	0.1474460	73 : 54	0.1309291	86 : 66	0.1149546	68 : 54	0.1001151	39 : 32	0.0859146
73 : 52	0.1473196	100 : 74	0.1307683	43 : 33	0.1149546	73 : 58	0.0998949	67 : 55	0.0857121
80 : 57	0.1472151	50 : 37	0.1307683	99 : 76	0.1148216	39 : 31	0.0997029	95 : 78	0.0856290
87 : 62	0.1471276	77 : 57	0.1306158	56 : 43	0.1147195	78 : 62	0.0997029	84 : 69	0.0854302
94 : 67	0.1470531	54 : 40	0.1303338	69 : 53	0.1145732	83 : 66	0.0995342	56 : 46	0.0854302
98 : 70	0.1461281	81 : 60	0.1303337	82 : 63	0.1144734	88 : 70	0.0993847	73 : 60	0.0851716
49 : 35	0.1461281	85 : 63	0.1300784	95 : 73	0.1144007	44 : 35	0.0993847	90 : 74	0.0850108
91 : 65	0.1461280	58 : 43	0.1299595	91 : 70	0.1139434	93 : 74	0.0992512	45 : 37	0.0850108
84 : 60	0.1461280	89 : 66	0.1298461	65 : 50	0.1139434	98 : 78	0.0991315	62 : 51	0.0848215
77 : 55	0.1461280	62 : 46	0.1296339	78 : 60	0.1139433	49 : 39	0.0991315	79 : 65	0.0847137
70 : 50	0.1461280	93 : 69	0.1296338	52 : 40	0.1139433	54 : 43	0.0989253	96 : 79	0.0846441
63 : 45	0.1461280	97 : 72	0.1294392	39 : 30	0.1139433	59 : 47	0.0987541	85 : 70	0.0843209
56 : 40	0.1461280	66 : 49	0.1293478	100 : 77	0.1135093	64 : 51	0.0986098	68 : 56	0.0843209
42 : 30	0.1461280	70 : 52	0.1290947	87 : 67	0.1134445	69 : 55	0.0984864	51 : 42	0.0843209
95 : 68	0.1452147	74 : 55	0.1288690	74 : 57	0.1133568	74 : 59	0.0983797	91 : 75	0.0839801
88 : 63	0.1451422	78 : 58	0.1286666	61 : 47	0.1132319	79 : 63	0.0982866	74 : 61	0.0839019
81 : 58	0.1450570	82 : 61	0.1284841	96 : 74	0.1130395	84 : 67	0.0982045	57 : 47	0.0837770
74 : 53	0.1449558	86 : 64	0.1283185	48 : 37	0.1130395	89 : 71	0.0981317	97 : 80	0.0836817
67 : 48	0.1448336	43 : 32	0.1283185	83 : 64	0.1128981	94 : 75	0.0980666	80 : 66	0.0835461
60 : 43	0.1446828	90 : 67	0.1281677	70 : 54	0.1127042	99 : 79	0.0980081	40 : 33	0.0835461
53 : 38	0.1444923	94 : 70	0.1280299	92 : 71	0.1125295	100 : 80	0.0969100	53 : 52	0.0833372
99 : 71	0.1443769	47 : 35	0.1280299	57 : 44	0.1124222	95 : 76	0.0969100	86 : 71	0.0832402
92 : 66	0.1442439	98 : 73	0.1279032	79 : 61	0.1122973	90 : 62	0.0969100	92 : 76	0.0829742
46 : 33	0.1442439	51 : 38	0.1277866	88 : 68	0.1119738	85 : 68	0.0969100	46 : 38	0.0829742
85 : 61	0.1440891	55 : 41	0.1275788	44 : 34	0.1119738	80 : 64	0.0969100	69 : 57	0.0829742
78 : 56	0.1439066	59 : 44	0.1273993	66 : 51	0.1119737	75 : 60	0.0969100	98 : 81	0.0827411
71 : 51	0.1436881	63 : 47	0.1272426	97 : 75	0.1117104	70 : 56	0.0969100	75 : 62	0.0826696
64 : 46	0.1434222	67 : 50	0.1271048	75 : 58	0.1116333	65 : 52	0.0969100	52 : 43	0.0825348
96 : 69	0.1434221	71 : 53	0.1269824	53 : 41	0.1114920	60 : 48	0.0969100	81 : 67	0.0824102
89 : 64	0.1432100	75 : 56	0.1268733	84 : 65	0.1113659	55 : 44	0.0969100	87 : 72	0.0821868
57 : 41	0.1430910	79 : 59	0.1267751	62 : 48	0.1111505	50 : 40	0.0969100	58 : 48	0.0821868
82 : 59	0.1429619	83 : 62	0.1266864	93 : 72	0.1111504	45 : 36	0.0969100	93 : 77	0.0819922
100 : 72	0.1426675	87 : 65	0.1266059	71 : 55	0.1108956	40 : 32	0.0969100	64 : 53	0.0819041
75 : 54	0.1426675	91 : 68	0.1265325	80 : 62	0.1106983	91 : 73	0.0957185	99 : 82	0.0818213
50 : 36	0.1426675	95 : 71	0.1264653	40 : 31	0.1106983	96 : 77	0.0957805	70 : 58	0.0816700
93 : 67	0.1424081	99 : 74	0.1264035	89 : 69	0.1105409	86 : 69	0.0956494	76 : 63	0.0814731
68 : 49	0.1423128	88 : 66	0.1249388	98 : 76	0.1104125	81 : 65	0.0955716	82 : 68	0.0813050
86 : 62	0.1421068	84 : 63	0.1249388	49 : 38	0.1104125	76 : 61	0.0954838	41 : 34	0.0813050
43 : 31	0.1421068	64 : 48	0.1249388	58 : 45	0.1102155	71 : 57	0.0953834	88 : 73	0.0811598
61 : 44	0.1418771	60 : 45	0.1249388	67 : 52	0.1100715	66 : 53	0.0952680	94 : 78	0.0810333

TABLE OF RATIOS FOR GEAR TRAINS—Continued

N.	Log. N.	N.	Log. N.	N.	Log. N.	N.	Log. N.	N.	Log. N.
47 : 39	0.0810333	91 : 78	0.0669468	68 : 60	0.0543576	99 : 90	0.0413927	61 : 57	0.0294549
100 : 83	0.0809219	84 : 72	0.0669468	34 : 30	0.0543576	88 : 80	0.0413927	46 : 43	0.0292893
53 : 44	0.0808232	77 : 66	0.0669468	94 : 83	0.0540498	77 : 70	0.0413927	92 : 86	0.0292893
59 : 49	0.0806559	56 : 48	0.0669468	77 : 68	0.0539818	55 : 50	0.0413927	77 : 72	0.0291582
65 : 54	0.0805196	49 : 82	0.0669468	60 : 53	0.0538754	44 : 40	0.0413927	62 : 58	0.0289637
71 : 59	0.0804063	42 : 36	0.0669468	86 : 76	0.0536849	66 : 60	0.0413926	93 : 87	0.0289636
77 : 64	0.0803107	70 : 60	0.0669468	43 : 38	0.0536849	33 : 30	0.0413926	78 : 73	0.0287717
83 : 69	0.0802290	63 : 54	0.0669468	69 : 61	0.0535193	100 : 91	0.0409586	94 : 88	0.0286452
89 : 74	0.0801583	35 : 30	0.0669468	95 : 84	0.0534443	89 : 81	0.0409050	47 : 44	0.0286452
95 : 79	0.0800965	99 : 85	0.0662163	78 : 69	0.0532455	78 : 71	0.0408363	63 : 59	0.0284885
84 : 70	0.0791813	99 : 79	0.0661607	52 : 46	0.0532455	67 : 61	0.0407450	79 : 74	0.0283954
60 : 50	0.0791813	85 : 73	0.0660960	87 : 77	0.0530286	56 : 51	0.0406178	95 : 89	0.0283336
54 : 45	0.0791813	78 : 67	0.0660198	61 : 54	0.0529360	90 : 82	0.0404286	96 : 90	0.0280287
42 : 35	0.0791813	71 : 61	0.0659285	96 : 85	0.0528523	45 : 41	0.0404286	80 : 75	0.0280287
96 : 80	0.0791812	57 : 49	0.0656788	70 : 62	0.0527063	79 : 72	0.0402946	64 : 60	0.0280287
90 : 75	0.0791812	64 : 55	0.0658173	35 : 31	0.0527063	68 : 62	0.0401172	48 : 45	0.0280287
78 : 65	0.0791812	100 : 86	0.0655015	79 : 70	0.0525291	34 : 31	0.0401172	32 : 30	0.0280287
72 : 60	0.0791812	50 : 43	0.0655015	88 : 78	0.0523881	91 : 83	0.0399633	97 : 91	0.0277303
66 : 55	0.0791812	93 : 80	0.0653929	44 : 39	0.0523881	57 : 52	0.0398716	81 : 76	0.0276714
48 : 40	0.0791812	86 : 74	0.0652668	97 : 86	0.0522732	80 : 73	0.0397671	65 : 61	0.0275836
36 : 30	0.0791812	43 : 37	0.0652668	53 : 47	0.0521780	69 : 63	0.0395086	98 : 92	0.0274383
97 : 81	0.0782867	79 : 68	0.0651182	62 : 55	0.0520290	46 : 42	0.0395085	49 : 46	0.0274383
91 : 76	0.0782278	72 : 62	0.0649408	71 : 63	0.0519178	92 : 84	0.0395085	82 : 77	0.0273232
85 : 71	0.0781606	36 : 31	0.0649408	80 : 71	0.0518317	81 : 74	0.0392533	99 : 93	0.0271523
79 : 66	0.0780832	65 : 56	0.0647254	89 : 79	0.0517629	58 : 53	0.0391521	66 : 62	0.0271522
73 : 61	0.0779931	94 : 81	0.0646429	98 : 87	0.0517068	93 : 85	0.0390640	33 : 31	0.0271522
67 : 56	0.0778868	87 : 75	0.0644580	99 : 88	0.0511525	70 : 64	0.0389180	83 : 78	0.0269835
61 : 51	0.0777596	58 : 50	0.0644580	90 : 80	0.0511525	35 : 32	0.0389180	50 : 47	0.0268721
55 : 46	0.0776049	80 : 69	0.0642409	81 : 72	0.0511525	82 : 75	0.0387526	100 : 94	0.0268721
98 : 82	0.0774122	51 : 44	0.0641175	72 : 64	0.0511525	94 : 86	0.0386294	67 : 63	0.0267343
49 : 41	0.0774122	73 : 63	0.0639824	63 : 56	0.0511525	47 : 43	0.0386294	84 : 79	0.0266522
92 : 77	0.0772971	95 : 82	0.0639097	54 : 48	0.0511525	59 : 54	0.0384582	51 : 48	0.0263290
86 : 72	0.0771660	88 : 76	0.0636691	45 : 40	0.0511525	71 : 65	0.0383449	85 : 80	0.0263289
43 : 36	0.0771660	44 : 38	0.0636691	36 : 32	0.0511525	83 : 76	0.0382645	68 : 64	0.0263289
80 : 67	0.0770152	66 : 57	0.0636690	100 : 89	0.0506100	95 : 87	0.0382043	34 : 32	0.0263289
74 : 62	0.0768400	81 : 70	0.0633870	91 : 81	0.0505564	84 : 77	0.0377886	86 : 81	0.0260135
37 : 31	0.0768400	59 : 51	0.0632818	82 : 73	0.0504910	72 : 66	0.0377886	69 : 65	0.0259357
68 : 57	0.0766340	96 : 83	0.0631931	73 : 65	0.0504095	60 : 55	0.0377886	52 : 49	0.0258072
99 : 83	0.0765571	74 : 64	0.0630517	64 : 57	0.0503051	36 : 33	0.0377886	87 : 82	0.0257054
62 : 52	0.0763884	37 : 32	0.0630517	55 : 49	0.0501666	96 : 88	0.0377885	35 : 33	0.0255541
93 : 78	0.0763883	89 : 77	0.0628993	92 : 82	0.0499739	48 : 44	0.0377885	70 : 66	0.0255541
87 : 73	0.0761964	52 : 45	0.0627908	46 : 41	0.0499739	97 : 89	0.0373817	88 : 83	0.0254046
56 : 47	0.0760901	67 : 58	0.0626468	83 : 74	0.0498464	85 : 78	0.0373243	53 : 50	0.0253059
81 : 68	0.0759761	82 : 71	0.0625556	74 : 66	0.0496878	73 : 67	0.0372481	71 : 67	0.0251835
75 : 63	0.0757208	97 : 84	0.0624924	37 : 33	0.0496878	61 : 56	0.0371418	89 : 84	0.0251107
100 : 84	0.0757207	90 : 78	0.0621479	65 : 58	0.0494854	49 : 45	0.0369836	90 : 85	0.0248236
50 : 42	0.0757207	75 : 65	0.0621479	93 : 83	0.0494048	98 : 90	0.0369836	72 : 68	0.0248236
94 : 79	0.0753008	45 : 39	0.0621479	56 : 50	0.0492180	86 : 79	0.0368714	54 : 51	0.0248236
69 : 58	0.0754211	60 : 52	0.0621480	84 : 75	0.0492180	74 : 68	0.0367228	36 : 34	0.0248236
88 : 74	0.0752510	98 : 85	0.0618072	75 : 67	0.0489865	37 : 34	0.0367228	91 : 86	0.0245429
44 : 37	0.0752510	83 : 72	0.0617456	94 : 84	0.0488486	99 : 91	0.0365938	73 : 69	0.0244738
63 : 53	0.0750646	68 : 59	0.0616569	47 : 42	0.0488486	62 : 57	0.0365168	55 : 52	0.0243594
82 : 69	0.0749648	53 : 46	0.0615181	66 : 59	0.0486919	87 : 80	0.0364293	92 : 87	0.0242685
57 : 48	0.0746337	91 : 79	0.0614143	85 : 76	0.0486053	100 : 92	0.0362122	74 : 70	0.0241337
95 : 80	0.0746336	76 : 66	0.0612697	95 : 85	0.0483047	75 : 69	0.0362122	37 : 35	0.0241337
38 : 32	0.0746336	38 : 33	0.0612697	76 : 68	0.0483047	50 : 46	0.0362122	93 : 88	0.0240002
76 : 64	0.0746336	99 : 86	0.0611367	57 : 51	0.0483047	88 : 81	0.0359977	56 : 53	0.0239121
89 : 75	0.0743287	61 : 53	0.0610539	38 : 34	0.0483047	63 : 58	0.0359125	75 : 71	0.0238030
70 : 59	0.0742460	84 : 73	0.0609564	86 : 77	0.0480078	76 : 70	0.0357156	94 : 89	0.0237379
51 : 43	0.0741017	92 : 80	0.0606978	67 : 60	0.0479235	38 : 35	0.0357156	95 : 90	0.0234811
83 : 70	0.0739801	69 : 60	0.0606978	96 : 86	0.0477727	89 : 82	0.0355761	76 : 72	0.0234811
96 : 81	0.0737862	46 : 40	0.0606978	48 : 43	0.0477727	51 : 47	0.0354723	57 : 54	0.0234811
64 : 54	0.0737862	100 : 87	0.0604807	77 : 69	0.0476416	64 : 59	0.0353280	38 : 36	0.0234811
77 : 65	0.0735773	77 : 67	0.0604159	87 : 78	0.0474247	77 : 71	0.0352324	96 : 91	0.0232298
90 : 76	0.0734289	54 : 47	0.0602959	58 : 52	0.0474247	90 : 83	0.0351644	77 : 73	0.0231678
45 : 38	0.0734289	85 : 74	0.0601872	97 : 87	0.0472524	91 : 84	0.0347621	58 : 55	0.0230653
58 : 49	0.0732319	93 : 81	0.0599979	68 : 61	0.0471791	78 : 72	0.0347621	97 : 92	0.0229839
71 : 60	0.0731070	62 : 54	0.0599979	78 : 70	0.0469966	65 : 60	0.0347621	78 : 74	0.0228629
84 : 71	0.0730210	70 : 61	0.0597682	39 : 35	0.0469966	52 : 48	0.0347621	39 : 37	0.0228629
97 : 82	0.0729578	78 : 68	0.0595857	88 : 79	0.0468556	39 : 36	0.0347621	98 : 93	0.0227432
91 : 77	0.0725507	39 : 34	0.0595857	98 : 88	0.0467434	92 : 85	0.0343689	59 : 56	0.0226640
78 : 66	0.0725507	86 : 75	0.0594372	49 : 44	0.0467434	79 : 73	0.0343042	79 : 75	0.0225658
65 : 55	0.0725507	94 : 82	0.0593140	59 : 53	0.0465761	66 : 61	0.0342141	99 : 94	0.0225073
39 : 33	0.0725507	47 : 41	0.0593140	69 : 62	0.0464577	53 : 49	0.0340798	100 : 95	0.0222764
52 : 44	0.0725507	55 : 48	0.0591215	79 : 71	0.0463688	93 : 86	0.0339844	80 : 76	0.0222764
98 : 83	0.0721480	63 : 55	0.0589778	89 : 80	0.0463000	80 : 74	0.0338583	60 : 57	0.0222764
85 : 72	0.0720864	71 : 62	0.0588666	99 : 89	0.0462452	40 : 37	0.0338583	40 : 38	0.0222764
72 : 61	0.0720027	79 : 69	0.0587780	100 : 90	0.0457575	67 : 62	0.0336831	81 : 77	0.0219943
59 : 50	0.0718820	87 : 76	0.0587057	90 : 81	0.0457575	94 : 87	0.0336086	61 : 58	0.0219018
92 : 78	0.0716932	95 : 83	0.0586455	80 : 72	0.0457575	54 : 50	0.0334238	82 : 78	0.0217193
46 : 39	0.0716932	88 : 77	0.0579920	73 : 63	0.0457575	81 : 75	0.0334237	41 : 39	0.0217193
79 : 67	0.0715523	80 : 70	0.0579920	60 : 54	0.0457575	95 : 88	0.0332409	62 : 59	0.0215397
99 : 84	0.0713559	72 : 63	0.0579920	50 : 45	0.0457575	68 : 63	0.0331684	83 : 79	0.0214510
66 : 56	0.0713559	64 : 56	0.0579920	40 : 36	0.0457575	82 : 76	0.0330003	84 : 80	0.0211893
86 : 73	0.0711756	40 : 35	0.0579920	91 : 82	0.0452275	41 : 38	0.0330003	42 : 40	0.0211893
53 : 45	0.0710634	96 : 84	0.0579919	81 : 73	0.0451621	96 : 89	0.0328812	63 : 60	0.0211892
73 : 62	0.0709312	56 : 49	0.0579919	71 : 64	0.0450783	55 : 51	0.0327925	85 : 81	0.0209339
93 : 79	0.0708558	48 : 42	0.0579919	61 : 55	0.0449671	69 : 64	0.0326691	64 : 61	0.0208302
100 : 85	0.0705811	97 : 85	0.0573528	51 : 46	0.0448124	83 : 77	0.0325874	43 : 41	0.0206846
80 : 68	0.0705811	89 : 78	0.0572954	92 : 83	0.0447097	97 : 90	0.0325292	86 : 82	0.0206846
60 : 51	0.0705811	81 : 71	0.0572267	82 : 74	0.0445822	98 : 91	0.0321847	65 : 62	0.0205217
40 : 34	0.0705811	73 : 64	0.0571429	41 : 37	0.0445822	84 : 78	0.0321847	87 : 83	0.0204412
87 : 74	0.0702876	65 : 57	0.0570385	72 : 65	0.0444191	56 : 52	0.0321847	88 : 84	0.0202034
67 : 57	0.0701999	57 : 50	0.0569049	62 : 56	0.0442037	42 : 39	0.0321847	66 : 63	0.0202034
94 : 80	0.0700379	98 : 86	0.0567276	93 : 84	0.0442036	70 : 65	0.0321846	44 : 42	0.0202034
47 : 40	0.0700379	49 : 43	0.0567276	83 : 75	0.0440168	99 : 92	0.0318474	89 : 85	0.0199711
74 : 63	0.0698912	90 : 79	0.0566154	52 : 47	0.0439054	85 : 79	0.0317918	67 : 64	0.0198948
54 : 46	0.0696360	82 : 72	0.0564814	73 : 66	0.0437790	71 : 66	0.0317144	90 : 86	0.0197440
81 : 69	0.0696359	41 : 36	0.0564814	94 : 85	0.0437090	57 : 53	0.0315990	45 : 43	0.0197440
88 : 75	0.0694214	74 : 65	0.0563183	84 : 76	0.0434657	100 : 93	0.0315171	68 : 65	0.0195955
61 : 52	0.0693265	99 : 87	0.0561159	42 : 38	0.0434657	86 : 80	0.0314085	91 : 87	0.0195221
95 : 81	0.0692386	66 : 58	0.0561159	63 : 57	0.0434656	43 : 40	0.0314085	69 : 66	0.0193052
68 : 58	0.0690809	91 : 80	0.0559514	95 : 86	0.0432251	72 : 67	0.0312577	92 : 88	0.0193051
75 : 64	0.0688813	58 : 51	0.0558578	74 : 67	0.0431569	87 : 81	0.0310343	46 : 44	0.0193051
82 : 70	0.0687159	83 : 73	0.0557552	53 : 48	0.0430347	58 : 54	0.0310342	93 : 89	0.0190929
41 : 35	0.0687159	75 : 66	0.0555174	85 : 77	0.0429282	73 : 68	0.0308140	70 : 67	0.0190232
89 : 76	0.0685764	100 : 88	0.0555173	64 : 58	0.0427520	88 : 82	0.0306688	94 : 90	0.0188854
96 : 82	0.0684573	50 : 44	0.0555173	96 : 87	0.0427519	44 : 41	0.0306688	47 : 45	0.0188854
48 : 41	0.0684573	92 : 81	0.0553028	75 : 68	0.0425524	59 : 55	0.0304893	71 : 68	0.0187494
55 : 47	0.0682648	67 : 59	0.0552228	86 : 78	0.0424039	74 : 69	0.0303826	95 : 91	0.0186822
62 : 53	0.0681158	84 : 74	0.0550476	43 : 39	0.0424039	89 : 83	0.0303119	96 : 92	0.0184834
69 : 59	0.0679971	42 : 37	0.0550476	97 : 88	0.0422890	75 : 70	0.0299633	72 : 69	0.0184834
76 : 65	0.0679002	59 : 52	0.0548487	54 : 49	0.0421977	60 : 56	0.0299633	48 : 46	0.0184834
83 : 71	0.0678198	76 : 67	0.0547388	65 : 59	0.0420614	90 : 84	0.0299632	97 : 93	0.0182888
90 : 77	0.0677518	93 : 82	0.0546690	76 : 69	0.0419645	45 : 42	0.0299632	73 : 70	0.0182249
97 : 83	0.0676936	51 : 45	0.0543577	87 : 79	0.0418922	91 : 85	0.0296225	98 : 94	0.0180982
98 : 84	0.0669468	85 : 75	0.0543576	98 : 89	0.0418361	76 : 71	0.0295553	49 : 47	0.0180982

any result, as it is necessary to select different sets of gears and try them until four such wheels are found as give the nearest satisfying ratio. And several multiplications and divisions will have to be done at each trial.

The method here described has none of these disadvantages. The whole operation is reduced to addition and subtraction of two or three logarithms. The manner of calculating is best demonstrated by the following example:

Ratio 1.71 : 1 . 4 gears.

1. Find in a table of ordinary logarithms log. 1.71 : 1 = 0.2329961.

2. Choose two numbers, for instance, $\frac{55}{34}$.

3. Find in the table here given log. $\frac{55}{34}$ = 0.2088838.

4. Subtract log. $\frac{55}{34}$ from log. $\frac{1.71}{1}$,

$$\begin{array}{r} 0.2329961 \\ 0.2088838 \\ \hline 0.0241123 \end{array}$$

5. Find in the table the nearest logarithm, which is 0.0241337 = log. $\frac{74}{70}$.

6. The wanted gears will then be

$$\frac{55 \times 74}{34 \times 70}$$

In order to obtain the degree of error, add log. $\frac{55}{34}$ and log. $\frac{74}{70}$, or

$$0.2088838 + 0.0241337 = 0.2330175.$$

Find N for log. 0.2330175 = 1.71008. Instead of 1.71 we have thus got 1.71008. The error in per cent. is therefore

$$100 \cdot \frac{1.71008 - 1.71}{1.71} = 0.0047 \text{ } \textit{per cent.}$$

If this degree of accuracy is considered insufficient, other numbers of teeth may be tried. For example,

$$\begin{array}{rl} \textit{log.}\ 1.71 & = 0.2329961 \\ -\textit{log.}\ \frac{68}{42} & = 0.2092596 \\ \hline & 0.0237365. \end{array}$$

Nearest log. = 0.0237379 = $\frac{94}{89}$; therefore, $\frac{68 \times 94}{42 \times 89}$ = 1.71; and checking for error is:

$$\begin{array}{r} 0.2092596 \\ 0.0237379 \\ \hline 0.2329975 \end{array}$$

the corresponding number for which is found to be 1.710006.

$$\textit{Error in per cent.} \frac{0.000006 \times 100}{1.71} = 0.00034 \text{ } \textit{per cent.}$$

By continued trials it is possible to arrive at still more accurate values. In order to obtain the greatest possible range of ratios, sometimes 6 gears are used. The calculation of these are done in the following manner:

Ratio: 2.4455 : 1, 6 gears.

$$\textit{log.}\ 2.4455 = 0.3883677.$$

Choose $\frac{68}{42}$, log. $\frac{68}{42}$ = 0.2092596.

Subtract:

$$\begin{array}{r} 0.3883677 \\ 0.2092596 \\ \hline 0.1791081 \\ 0.1249387 \\ \hline 0.0541694 \end{array}$$

Choose $\frac{52}{39}$, log. $\frac{52}{39}$

Nearest log. 0.0540498 = log. $\frac{94}{83}$;

$$\text{therefore } 2.4455 : 1 = \frac{68 \times 52 \times 94}{42 \times 39 \times 83}$$

and checking for error is:

$$\begin{array}{rl} \textit{log.}\ \frac{68}{42} & = 0.2092596 \\ \textit{log.}\ \frac{52}{39} & = 0.1249387 \\ \textit{log.}\ \frac{94}{83} & = 0.0540498 \\ \hline & 0.3882481, \end{array}$$

and corresponding number N = 2.44483.

$$\textit{Error in per cent.} \frac{2.4455 - 2.44483}{2.4455} = 0.0275 \text{ } \textit{per cent.}$$

The result arrived at is unsatisfactory, wherefore a new trial is made.

$$\begin{array}{rl} \textit{log.}\ 2.4455 & = 0.3883677 \\ \text{Choose } \frac{61}{38} \text{ and } \textit{log.}\ \frac{61}{38} & = 0.2055462 \\ \hline & 0.1828215 \\ \text{Choose } \frac{38}{30} \text{ and } \textit{log.}\ \frac{38}{30} & = 0.1026623 \\ \hline & 0.0801592 \end{array}$$

Nearest log. 0.0801583 = log. $\frac{89}{74}$ and checking for error is:

$$\begin{array}{rl} \textit{log.}\ \frac{61}{38} & = 0.2055462 \\ \textit{log.}\ \frac{38}{30} & = 0.1026623 \\ \textit{log.}\ \frac{89}{74} & = 0.0801583 \\ \hline & 0.3883668 \end{array}$$

and corresponding number N = 2.445495.

$$\textit{Error in per cent.} \frac{0.000005}{2.4455} \times 100 = 0.000202 \text{ } \textit{per cent.}$$

As will be seen from the above-mentioned examples, the desired accuracy is easiest obtained by choosing the first or both the first logarithms, so that the last logarithm wanted will be as small as possible—that the proportion between the two last gears is very near 1, as the difference between two logarithms following upon each other in the table is the smallest one.

It is a good plan to check the obtained results, in case an error either in the printing or the calculation should exist.

By repeated trials it is generally quite easy to come to an accuracy of 0.0001 per cent.

It is quite clear that a better result is obtained with six gears than with four.

For less accurate calculations it is of course quite sufficient to use five-place or less logarithms instead of the seven-place ones given in the tables.

The tables will be completed in the next issue.

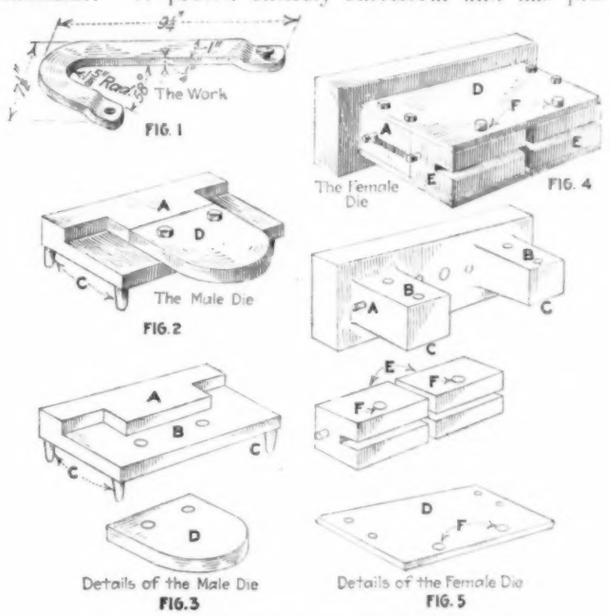
Nickel-Chromium Steel—The addition of chromium to nickel steel has a marked effect, greatly increasing the strength and resistance to shock and particularly the mineralogical hardness. It is more difficult to forge and heat-treat and harder to machine. It is also liable to the seaminess frequently present in nickel steel. There are three types of this steel, differing both in the percentage of nickel and of chromium and all with low or medium carbon: (1) Nickel, 3.5%, chromium 1.50%, carbon 0.25% to 0.45%; (2) 2%, 1%, 0.10% to 0.45%; (3) 1.5%, 0.50%, 0.10% to 0.45%. The first type is used principally for armor plate and armor-piercing projectiles and came into use about 1895, superseding the nickel plates and chromium projectiles. The other two types were developed by the automobile industry. The second type is largely for automobile forgings. It gives high strength with heat-treatment, has great hardness and good shock- and fatigue-resisting qualities. The third type is a largely used all-round engineering steel. It is used for automobile forgings and for a variety of miscellaneous drop-forgings and machine parts. It is an excellent case-hardening steel, carbonizing readily.

Letters from Practical Men

The Design of Dies for Edge Bending of Light Metal

We had to make a large quantity of pieces like those shown in Fig. 1. They are of ordinary soft-steel merchant-bar stock, about 15-point carbon. The finish and tolerances are about the same as for an ordinary drop forging. As it was necessary to produce them at a very low cost, we could not afford to heat them, so decided to make them cold. We first tried bending them in a punch press, but this was not successful on account of the wear of tool and the time required to do the work.

I finally designed and built a die to be used in the bulldozer. It proved entirely successful and has produced a great many thousand pieces without any cost for repairs.



DIES FOR EDGE BENDING

Fig. 4 shows an assembled view of the female portion of the die and Fig. 2 that of the male portion. Fig. 5 gives the details of the female die. A cast-iron base or frame *A*, Fig. 5, is machined on the base and on faces *B* and *C*. Two pieces of ¾-in. boiler plate *DD*, finished on the edges only, are secured to *A* by four ⅝-in. bolts. Two pieces of tool steel *EE*, 2x2½ in., are finished all over and have a slot ⅞x$\frac{9}{32}$ in. cut across the front faces and hardened.

These pieces are secured between the two pieces of boiler plate and pivot on studs through holes *FF*. They also have a stud in the rear outside end, with a hole drilled through for a helical spring. The other end of this spring is secured to the casting *A* and serves to return these jaws to a straight line when the operation is finished.

Details of the male die or punch are shown in Fig. 3. A cast-iron base *A* is finished on the back, top face *B* and on faces of legs *C*. The tool-steel die *DB* is 1 in. thick and is secured to *A* by two machine screws. It projects over the front of *A*.

In setting up this die, the female portion is secured to the movable head of the bulldozer by bolts and dowel pins and the male portion is bolted to the bedplate. The legs *C* are the proper height to bring the two dies in correct alignment, and are located by means of the adjusting screws on the bulldozer.

The operator then places his stock (previously cut to length and rounded on the ends) in the slot of the female die. One stroke of the machine does the bending. The piece is then shoved out of the die by a knockout rod secured to the rear of bulldozer frame, but not shown, and drops into a box underneath the machine. The two offsets shown in Fig. 1 are made in a second operation under another press.

The bulldozer is speeded to 35 strokes per min., and the operator soon becomes so proficient that he can easily catch every stroke of the machine.

It can be readily seen that a number of similar pieces can be made with the same style of die by using different shaped jaws. In fact, we bend on one kind of die about six different articles, one of which is an S bend of stock 1 in. wide and No. 10 gage thick (bent on edge).

We find that the comparatively slow speed of the machine is a very distinct advantage, as it gives the metal in the stock time to flow and avoids breakage.

The articles on which those pieces are used belong to a line which is highly competitive, yet we have made some very satisfactory reductions in cost by the use of this and similar dies.

B. W. SANDERSON.

Chicago, Ill.

Machining Gear Roller Faces

A number of gear blanks as shown in Fig. 1 required machining on the face *A*, a finished sample being sent in with the job. The face had an irregular contour, starting at *B*, increasing to ½ in. in height at the point

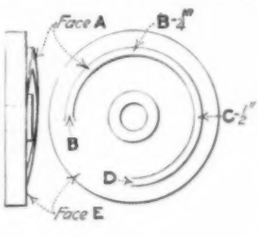


FIG. 1. THE PART TO BE MACHINED

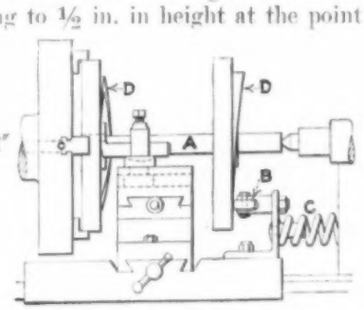


FIG. 2. THE METHOD USED FOR THE WORK

C, 180 deg. from *B*, and decreasing at *D*, 90 deg. from *C*, the remaining 90 deg. from *D* to *A* being the line of the face *E*. The faces were finished in a lathe as follows:

A taper bushing, smaller inside than the bore of the hub, was fitted into the center hole of a hollow spindle lathe, Fig. 2. Then one end of the mandrel *A* was

fitted into the bushing and the other end driven into the sample gear. A piece of angle iron with roller *B* and spring *C*, suitably fastened, was bolted across the ends of the carriage and the equipment was ready for use.

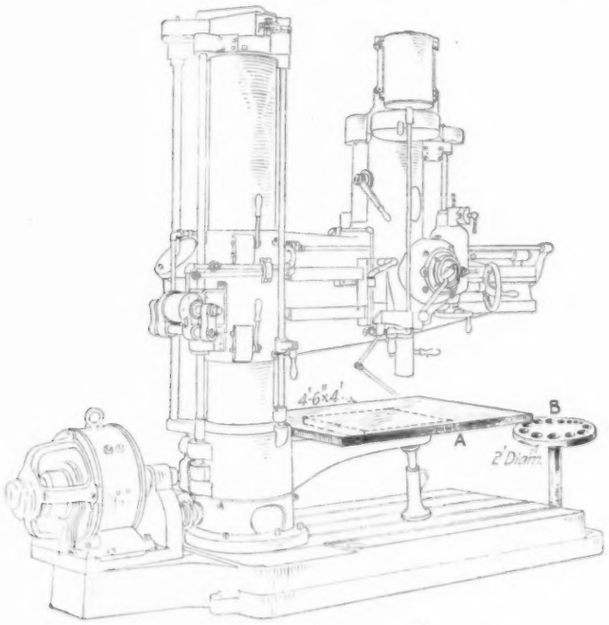
After the hub of each gear was bored the lathe spindle was revolved to bring the starting point to the height of the point of the tools. The mandrel was then inserted through the hub into the bushing in the spindle and placed with the starting point on the sample gear in line with the roller *B* and the mandrel then driven into the bushing.

When cutting across the face *D* the compressed spring *C* forced the carriage and tool toward the cut, thus keeping *B* in contact with *D* on the sample and producing a similar face on the piece being machined.

Greenville, Penn. F. M. A'HEARN.

Increasing the Capacity of a Radial Drilling Machine

In manufacturing a line of gas engines with a limited number of machine tools the attachments for the radial drill described herein effected a considerable saving. The base and cylinder of the smaller sizes of engines require a numbr of operations on the drilling machine, such as drilling, reaming, facing, tapping for studs and pipe plugs, as well as stud-setting. The different operations necessitate different positions and angles and involve the use of several fixtures and jigs. The area of the swinging



INCREASING THE CAPACITY OF A RADIAL DRILLING MACHINE

table proved entirely inadequate to accommodate the necessary changes, so a cast-iron sub-table or plate *A* of a well-ribbed section was bolted securely to the swinging table of the machine. In this way all operations were handled consecutively in the proper jigs and fixtures, without the operator having to lift anything but the casting, and that only from the floor to the table.

A revolving cast-iron table or stand *B*, with a series of holes of the proper size drilled around its periphery to accommodate the shank of a "Wizard" chuck collet, was another addition. The operator arranges his tools in the order in which they are needed and turns the table as he needs the different drills, taps or reamers. Both these simple attachments have proved valuable and are in almost constant use. H. E. MCCRAY.

Charles City, Iowa.

Ribbed Glass for Shop Lighting

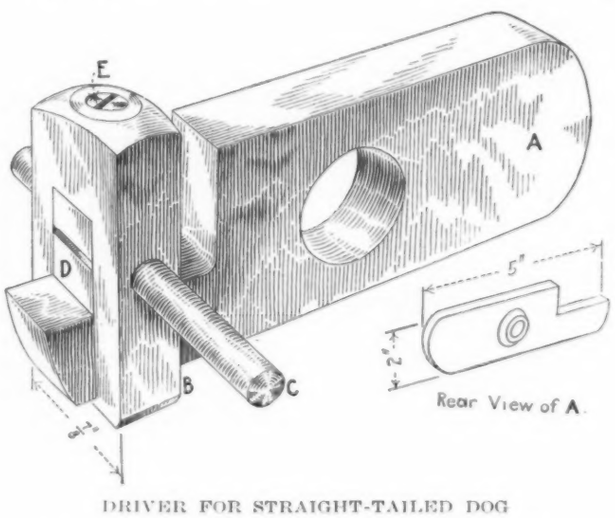
I have an idea that it is not generally known what a vast advantage there is in using ribbed glass in preference to plain glass for shop lighting.

Our pattern shop is 32 ft. wide, and all the light comes from one side. When the shop was built and before the glass was put in, I was afraid that it would be so dark that it would be a failure. But I thought of Edward Atkinson's report as to the advantage of ribbed glass, and used it. The result was marvelous, the whole room being lighted to perfect satisfaction.

Syracuse, N. Y. JOHN E. SWEET.

A Substantial Driver for Straight-Tailed Dogs

I always wanted a mechanical device similar to the one illustrated for driving straight-tail carriers. I believe the straight-tail carrier is always looked upon as being better than the bent tail. I have experienced the difficulties and troubles of having to use a bolt and packing clamped on the small faceplate. Either the carrier wedged against the nuts, the bolt would not be long



DRIVER FOR STRAIGHT-TAILED DOG

enough or some other time-consuming trouble would come up.

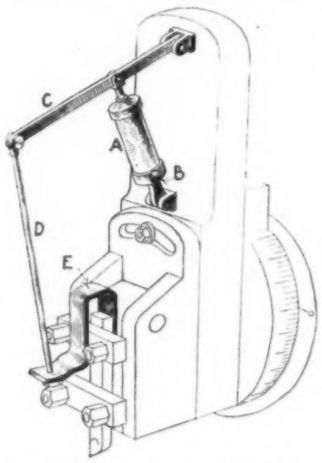
The device shown was made for an 18-in. Barnes lathe and eliminates the above-mentioned troubles. The body *A*, which is threaded to suit the spindle nose, is of cast iron. It is cut away at one end a width of ¾ in., on which the part *B* carrying the driving pin *C* slides and is locked in the desired position. The part is of mild steel, slotted to slide on the body *A* and also to receive the tool-steel clamp, which is split to hold the driving pin. This in turn is clamped up by the ⅜-in. hollow square-hole screw *E*. A spring is provided in a drilled hole, so that the sliding members are held in tension should the screw be loosened for adjustment.

The small wrench *F* is for the screw *E*. The driving pin is of ⅜-in. drill rod, 3 in. long, which is a convenient length for average work, but a longer pin can readily be put in position for any special job.

Wembly, England. J. H. DAVIS.

Pneumatic Tool Lifter for Planing Operation

A large amount of work to be done on a planer consisted of big bedplates and other long pieces. Judging by the quantity of metal removed, the planer tools were wearing out fast. A little study showed that the abuse of the tool on the return stroke was responsible for this wear, especially when planing the bottom of bedplates, where the tool would rap severely against the webbing. The pneumatic tool lifter here shown solved the trouble. The apparatus consists of a cylinder and piston *A* supplied with compressed air at about 75 lb. pressure through the opening *B* by means of an air hose from the controller valve. The piston rod is connected to the lever *C*, which is fulcrumed at one end. As the air is applied to the piston, the lever lifts the tool jack by means of the rod *D* and lifter bracket *E*. It will be noticed that the end of the lifter bracket on which the rod lifts is spherical. It was made this way in order that the tool jack might be used at an angle. In operation it was found possible to use the lifter successfully when the tool jack was at an angle of 20 deg. with the vertical.



PNEUMATIC TOOL LIFTER FOR PLANER OPERATION

A three-way air valve was connected to the belt shifter at the side of the planer and timed so as to admit air to the cylinder at the beginning of the return stroke and exhaust it at its completion, thus lifting the tool from the work during the return stroke and dropping it back in place just before the cutting stroke.

In case of short work, where it was not desired to use the lifter, the rod was unhooked and swung up out of the way. W. BURR BENNETT.

Bridgeport, Conn.

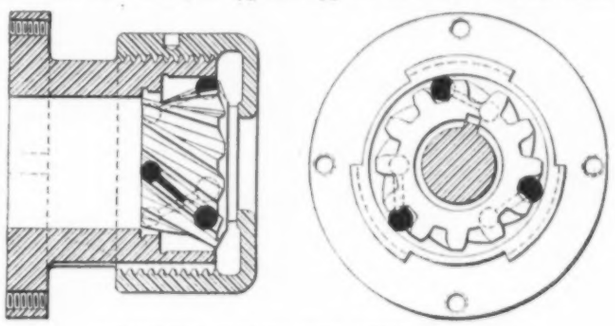
Grinding Chuck for Bevel Gears

The illustration shows a device used in grinding spiral-type bevel gears. This is quick to operate and holds the gears practically perfect on the pitch line while the hole is being ground.

The body *A* of the chuck is tool steel and hardened. It is made with two steps, the first larger, to hold the large end of the pinion; the rear one is to hold the small end of the pinion. Three balls are used on each end, making a six-point bearing.

The outside of the chuck body has a 6-pitch thread, milled out in three parts and with a flange convenient to clamp on any faceplate. The hood *B* is made of cast iron, knurled on the outside, the inside threaded to fit the chuck. Three spaces are milled out of the thread to slip over the thread of the chuck when clamping the two parts together.

The pinion is held firmly within the chuck by a system of links and balls, of ⅜ and $\frac{5}{16}$ in. diameter. The links


GRINDING CHUCK FOR BEVEL GEARS

or rods are of ⅛ in. diameter and tapped into the balls.

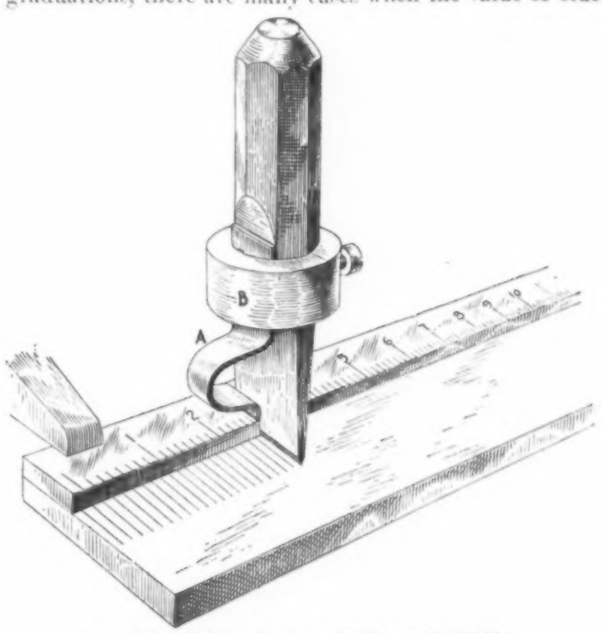
By taking two of these links and holding them on opposite sides of the pinion in the tooth space and placing the gear on a parallel, the diameter at both ends can be measured and the inside of the chuck ground accordingly.

The three sets of links are secured by a wire to a collar (not shown) which keeps them correctly spaced and easier to handle. This same fixture can also be used on straight-tooth pinions by having the correct length of the ball links. JOHN KRUNSLER.

Cleveland, Ohio.

Method of Marking Divisions on Flat Surfaces

While modern machine tools are as a rule equipped with graduations, there are many cases when the value of older



EASY METHOD OF MARKING DIVISIONS

machines, tools, jigs and special fixtures would be greatly increased by the addition of scales to indicate the position of a slide or adjustable part.

With a tool such as is shown in the illustration very creditable scales may be made on tailstock spindles, slides or other parts. The spring *A*, bent up from a piece of spring hoop steel, is secured to a small cold chisel. About two-thirds of the side of the chisel is filed or ground away as shown, so that the sharpened lower end of the spring *A* may come in line with the cutting edge of the chisel.

The spring is secured to the chisel with a strong collar *B*, the point of the setscrew resting in a recess in the chisel. This spring should exert a slight pressure against the portion of the chisel which is left to form a guide. The spring may be made from tool steel and properly tempered if no spring hoop steel is at hand.

A thin scale is clamped in position on the part to be graduated and a series of uniform marks made. These marks may be lengthened with an ordinary chisel if desired or extra length may be given to the prominent divisions.

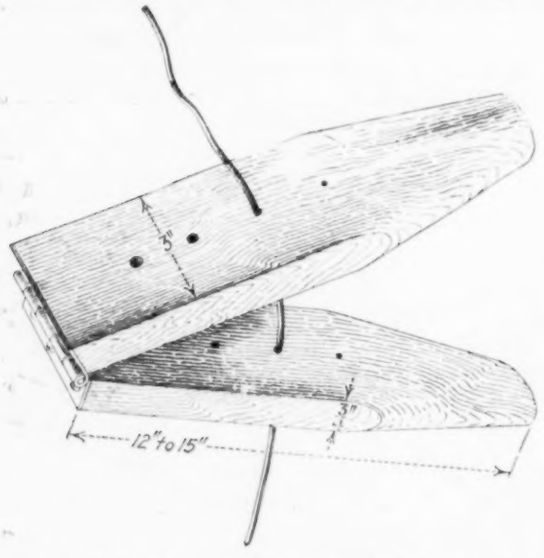
Steel figures or even center punch marks may be used to indicate the inch or other divisions, and the whole smoothed off with a file. C. W. MEGGENHOFEN.

Indianapolis, Ind.

A Cheap Wire Straightener

The simple tool illustrated here has often been used by me for straightening hard, springy brass or phosphor-bronze wire. It is rather difficult and slow to straighten wire (up to about $\frac{3}{16}$ in. diameter) without getting kinks. The device shown has proved very helpful and practical.

Two boards of hard wood are held together by a hinge. Holes for the different sizes of wires to be straightened



A CHEAP WIRE STRAIGHTENER

are drilled through both boards so that the wire just passes through easily.

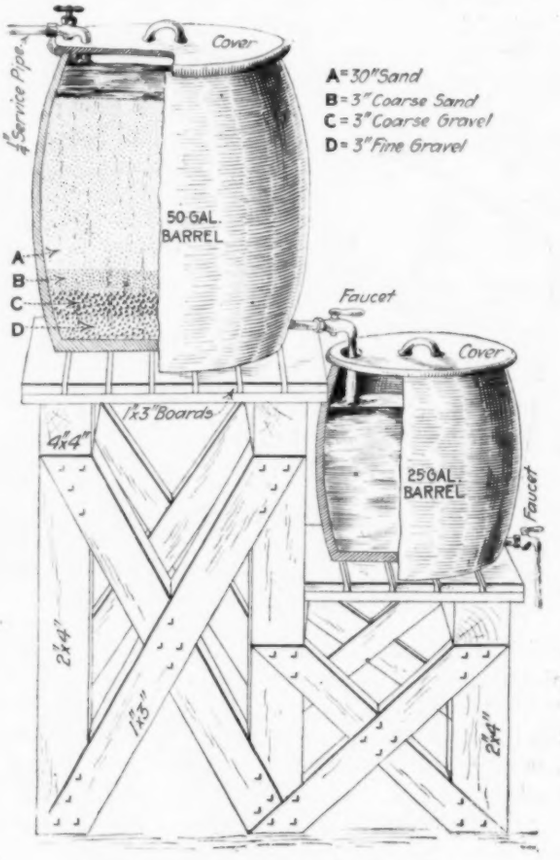
An end of the wire is held in a small drill chuck or the spring chuck of a lathe revolving at a medium speed. The tool is slowly drawn away from the chuck and at the same time the two boards are pulled apart a trifle. The wire will bend slightly, but a perfectly straight rod will be the result. The wire should be lubricated a little to make it slide easily. GUSTAVE KOPSCH.

Plainfield, N. J.

A Home-Made Water Filter

Having experienced a lot of difficulty with the drinking water in our factory and tried various kinds of faucet nozzles, which did not seem to remedy matters much, we experimented with the arrangement shown in the illustration, which is giving satisfaction.

A 50-gal. barrel was filled with layers of sand and gravel in the proportions shown, leaving the space at



A HOME-MADE WATER FILTER

the top, which holds 7 gal. of water. This space was intermittently fed with water from the service pipe, allowing the sand to drain after each filling.

When the sand at the top became clogged, we removed the upper 4 in. and made a scraping 1 in. deep, refilling with fresh sand to the original level. The platform and stand construction requires no explanation.

New York, N. Y. G. WEBER.

Two Types of Silicon Steel, one of which has found some application as an engineering steel, were described in a symposium on iron and steel presented to the International Engineering Congress. The engineering type, frequently called silico-manganese steel, is generally covered by the following limits of composition: Carbon, 0.45% to 0.65%; silicon, 1.50% to 2.00%; manganese, 0.50% to 0.80%. The manganese is normal, contrary to what is indicated by the name. The principal application of this steel is for automobile springs, and to some extent for gears. It fibers readily through heat treatment and is very brittle in the direction at right angles to rolling. It is very sensitive to heat treatment, and a relatively small variation in annealing temperature after quenching has a strong effect on the results obtained. The other type of silicon steel contains 3% to 5% silicon, is low in carbon and manganese and is extensively used for electrical transformer sheets on account of its high permeability and electrical resistance. Structurally it is weak and has no constructional value.

Thirty-Sixth Annual Meeting of Mechanical Engineers

SYNOPSIS—Industrial safety was the subject of the keynote session of the best-attended annual meeting ever held by the American Society of Mechanical Engineers. The address of the retiring president, Dr. John A. Brashear, emphasized the scientific basis of all engineering and made a plea for a more intimate relationship between scientific research and engineering application. Two papers and a report taking up the automatic control of machine tools and a safety code for abrasive wheels were presented at the machine-shop session.

It has become a recognized custom to prepare for a keynote session at each annual meeting of the American Society of Mechanical Engineers. The subject selected for this purpose at the thirty-sixth meeting, held in New York, Dec. 7-10, was "Industrial Safety." Four papers were presented.

A well-attended session prepared for by the committee on machine-shop practice discussed both mechanical and electrical control for automatic machines and considered a proposed code for the care and operation of abrasive wheels.

Many favorable comments were made on the feeling of good fellowship that existed throughout the sessions and on the success of all the social features. The "smoker" on Wednesday evening was in the nature of an innovation that can very well be followed in future years. The usual dinner dance was held at the Hotel Astor on Thursday evening. The number of excursions was smaller than usual, but those selected had particular features of interest that called out some of the largest attendances that the society has ever known. The special feature of the ladies' entertainment was a luncheon on Thursday, at the invitation of Mrs. Harrington Emerson.

Dr. Brashear's Presidential Address

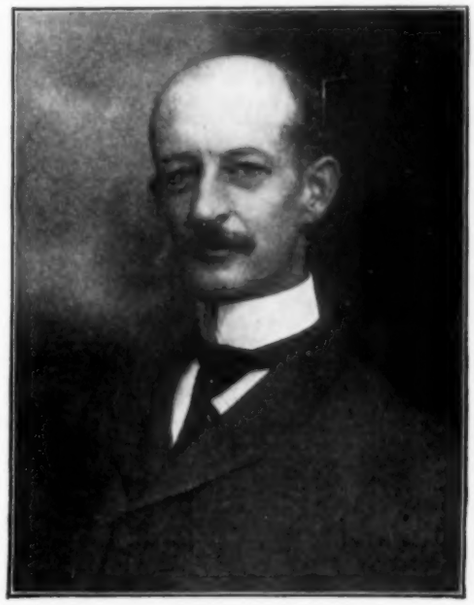
Dr. John A. Brashear, the retiring president, is widely recognized as one of the most pleasing speakers on scientific subjects. His presidential address on the subject of "Science in Its Relation to Engineering" was delivered in his most happy manner, which puts the audience completely at ease after only a few sentences have been spoken and holds their close attention to the end.

While pointing out the great debt that engineers owe to scientists of the past, Dr. Brashear presented the æsthetic side of science and here and there touched upon many of its beauties. He challenged the attitude held toward science by many people of intelligence even today, which leads to the thought that science destroys the mysteries of the beautiful things around us and explains and catalogs them in a dull, uninteresting way. In offsetting this viewpoint, he quoted from Dr. Maclaurin as follows:

> The complaint seems to be that science with its analysis of color robs us of the pleasing sense of awe and mystery; but if you dig deep, you will find enough mystery left to satisfy the keenest yearn after half lights and the obscure. At best, science replaces one mystery only by another of grander order.

The following excerpts from Dr. Brashear's address trace the relationship between some of the engineering achievements of today and the work of pioneer scientists of the past. It also makes the plea for a closer and more intimate relationship between present-day scientific research and engineering application.

> The early history of engineering in at least three of its phases—namely, civil, mining and mechanical—has much of interest to the technical student of today, and we of the twentieth century would be false to our convictions did we not give our meed of praise to the pioneers who have left in evidence some of the monuments of their labors which stand almost unimpaired after the ravages of many centuries.
>
> It is a long way from the sun dial of Ahaz to the Riefler clock; a long way from the pyramid of Cheops to the stately steel structure of our great cities; a long way from the cubit span and handbreadth to the standard meter whose value is determined in light waves; a long way from the ox-cart with its wheels cut from the end of a log to the steam and electric locomotive; a long way from the log bridge across the narrow streams to the magnificent steel and concrete spans that now cross our widest rivers; a long way from the tiny Egyptian cedar boat, built without iron, steel or copper, to the majestic steel steamships that daily cross the ocean; a long way from the smoke balloon of Montgolfier to the dirigible, or the biplane that soars like a bird through our skies; yes, and all along the pathway of the evolution of these and other inventions of man are unwritten histories which, if told, would be filled with romance and ofttimes with tragedies—aye, with the sacrifice of the lives of many of the world's noblest pioneers who have contributed to the treasures of our vast storehouse of knowledge.
>
> We can look over time's vistas and learn that to Aristotle we owe the beginning of exact science and research, fostered by his love of experimentation. Indeed, Hale records that, although his theory of the fixity of the earth was based upon false premises, he left his impress so deeply upon the islands and borderlands of the Mediterranean that after he had passed from his labors, there was a gradual separation of the investigations in natural science from the speculations of the philosophers, and that true scientific research, in the modern sense, developed with remarkable rapidity.
>
> I have always had the conviction that we give too little thought to the pioneers in any line of research, and I have often bowed my head in reverence to those who, with the most limited means and equipment, by patient, persistent plodding, wrested the secrets of nature from their entanglement.



DR. D. S. JACOBUS
Newly elected president of A. S. M. E.

There has often arisen in my own mind, and no doubt in yours, the question, Where shall we draw the line between pure and applied science? For myself I have been unable to find aught but a hazy line of demarcation, and in my long life I have known but few men who, in their mathematical researches and calculations, could see nothing in the way of an entity before them; indeed but one great mathematician has told me it was his regret that he could see no picture of a beautiful comet while he was calculating its orbit, nor could he form a visual image of the planetary world whose perturbations he was computing by his wonderful mathematical formulas.

Nor can I see how pure science and its allies can be relegated to opposite poles. For a time apparently they may point in opposite directions, but at each end there lies some great truth. One may be a hitherto undiscovered law of nature and the other, let us say, something of a utilitarian character that, material as we may call it, will cause these opposite poles to curve toward each other and add to the sum of human knowledge, human betterment and happiness.

Let me illustrate. When the velocity of the propagation of light waves was determined by scientific reasoning and experimentation of the most refined nature, and successively by Roemer, Bradley, Fizeau, Foucault and our own Newcomb and Michelson, the process of solving the problem remained for a long time in the domain of the exact sciences as a masterpiece of the human mind.

But who of us dreamed to what a utilitarian purpose these light waves would be made subservient? The genius of a Michelson carried them into the workshop, thence to the International Bureau of Weights and Measures at Sèvres, and gave us a value for the International meter in terms of light waves that will remain absolutely unalterable as long as this old world moves in the luminiferous ether of the universe. And so we now know that our standard meter, measured in terms of the red radiations, or wave length, of cadmium, equals 1,553,163.5; for the green radiation, equals 1,966,249.7; and for the blue radiation, 2,083,372.1, in air at 15 deg. C. and normal atmospheric pressure.

Michelson tells us that the absolute accuracy of these measures is one part in two millions, the relative accuracy one part in twenty millions.

WORKING TO MILLIONTHS ON SCREWS

Getting nearer the utilitarian service of the scientific study of light waves, let me say that Dr. Anderson, of the Johns Hopkins University, has utilized them in making screws of hitherto unheardof accuracy[1]. Let me quote from a letter received from Dr. Anderson before writing this address:

In reply to yours of the fourth, I will say that from measurements made by using a Fabry and Perot interferometer, the screws we have made for ruling purposes have the following accuracy:

1. The maximum variation in pitch along the screw did not exceed one ten-millionth of an inch. (By pitch I mean the average value of the pitch as given by a well-fitting nut 3 or 4 in. long.)
2. The axis of the screw had a radius of curvature longer than 250 miles.
3. The axis of each pivot or bearing coincided with the axis of the screw to within one two-hundred thousandths of an inch.

These are three important quantities as far as the screw itself is concerned.

When the screw is mounted ready for use, it is also important that it be prevented from moving endwise or longitudinally when it is rotated. Our mounting, using the flat ruby against a spherical steel surface, makes it possible to reduce this motion to something less than one-millionth of an inch. Errors of the magnitude given above can be easily detected with the interferometer.

Our fellow member George M. Bond has given us a most valuable compendium of the development of measures of precision in his work on "Standards of Length," from which I quote as most interesting, and bearing forcibly upon this part of our topic:

It is worthy of note that remedy for the evil complained of by master car builders, that nuts made by some firms or at some shops would not screw on bolts made by others, at first baffled the ability of the most prominent manufacturers of tools of precision in the country, and that to provide an adequate remedy it was necessary to secure the assistance of the highest scientific ability in the country, which was supplied through the coöperation of the professor of astronomy of the oldest and most noted institution of learning in the land. The man of science turned his attention from the planets and the measurement of distances counted by millions of miles to listen to the imprecation, perhaps, of the humble car-repairer lying on his back and swearing because a ⅝ nut—"a leetle small"—will not screw on a bolt—"a trifle large." It is a striking example of the assistance which science can give in conducting the "practical" affairs of life.

Here I wish to pay a tribute to our American engineers who have developed instruments for mechanical measurements to such a high state of precision, which in their turn have been such mighty factors in the development of interchangeable machinery. I need not dilate upon these interesting topics, but I cannot refrain from offering a word of praise to these earnest men whose ideals have been of the highest—by their work we know them.

I am sure all will be interested in what may be called a paradoxical statement—but is not—namely, that through the marvelous precision attained by Rowland, and later by Anderson, in the construction of accurate screws, we have made what must be considered a utilitarian use of pure scientific research. This utilitarian use of science has reacted, as it were, and enabled the scientific mechanician to produce an optical device that rivals, if it does not surpass, the telescope in unraveling some of the most profound secrets of the universe.

I hold in my hand [shows a diffracting grating] a little instrument called a diffraction grating. On the plane surface of this polished plate, made accurate to one-tenth of a light wave, or within one forty-five thousandth of an inch, are ruled more than 45,000 lines between which there is no greater error than one two-millionths of an inch. With this delicate piece of apparatus, made possible first by rigorous scientific research, second by the skill of the artisan, third by a knowledge of and vigorous care to avoid temperature changes and fourth by the accuracy of the mechanism which includes the accurate screw mentioned above, the astrophysicist has been able to tell us the composition, temperature and distance of the stars. It is also possible for the physicist, the chemist, to tell us the purity of the material he is called to investigate; indeed, it makes itself subservient to many phases of engineering in the domain of metallurgy. And the end is not yet. Where can we then draw a sharp line of demarcation between pure science and its relation to any and every form of engineering?

COUPLING SCIENCE AND ENGINEERING

Twenty-seven years ago I was the guest of my friend Sir James Dewar, the worthy successor of Tyndall in the Royal Institution of Great Britain. Taking a tiny piece of apparatus out of the "holy of holies," and placing it in my hands, he told me it was the father and mother of all the dynamos and electric-lighting systems of that day. It was the first little dynamo made by Michael Faraday. What has come to us since that visit, in the domain of the electric development through scientific investigation and mechanical devices!

Thirty-seven years ago I listened to the first faint telephone message over a few miles of wire. On the twenty-fourth of January last, through the courtesy of our friend Mr. Carty, chief engineer of the American Bell Telephone Company, and Dr. Bell, I listened to the voices of Watson and Moore across the continent. When this society was the guest of the officials of the Panama-Pacific Exposition, I was taken to the private office of the telephone company in the Exposition building, where, through the courtesy of our friend Engineer Carty, I not only listened to cheerful words spoken in this city, but heard the sound of the breakers as they dashed upon the shore of the Atlantic.

When we made the first little spectroscope to determine the moment when the last ounce of carbon had disappeared from the Bessemer converter, little did I dream that through science, aided by a delicately accurate instrument devised by my good friend Dr. George Ellery Hale and made at "the little workshop on the hill," we would be able to plunge it, as it were, into a storm on the sun and photograph the burning hydrogen or any other element in that maelstrom of fire, the temperature of which this earth knows no correlative.

Here let me add some altruistic words of our good friend Dr. Pritchett:

The last fifty years have seen a greater betterment of the theoretical basis of physical science than ever before in the history of the world. This development has been marked by a notable stimulation of scientific research, a differentiation of scientific effort, and the creation thereby of a great number of special sciences or departments of science. The possession of a secured theoretical basis and the intellectual quickening which has followed it have resulted in the application of science to the arts and to the industries in such measure as the world has never before known. These applications have to do with the comfort, health, pleasure and happiness of the human race, and affect vitally all the conditions of modern life.

And is there not a splendid field opened up to us in the endowment of engineering research, now made possible by the gift of one of our honored presidents? I have said little of specific lines of investigation in relation to engineering, having given only a few instances to show their close and intimate relationship, and it needs no further words of mine to verify the aphorism that "the field is ripe for the harvest."

There has now come to us a grand opportunity and we may look forward with hope to the day when science and engineering will join hands for the betterment of our loved profession.

(Continued on page 1096)

[1]The methods and tools used in making these screws were described in "American Machinist," Vol. 40, pp. 881 and 969. —Editor.

Editorials

Britain Restricts Machine-Tool Importation

The greatest excitement that the American machine-tool building industry has had since the opening of the war came last week, when the Department of Commerce announced in the *Commerce Reports* for Monday, Dec. 6, that Great Britain by royal proclamation had placed a prohibition on the importation of machine tools into the United Kingdom. This information reached the department in a telegram from the American embassy in London dated Dec. 2. This telegram reads:

"A royal proclamation, published Nov. 30, 1915, prohibits, after Dec. 21, the importation into the United Kingdom of all machine tools and parts thereof, except small tools. A further exception is made in favor of machine tools and parts thereof imported under the license of the Board of Trade and subject to the provisions and conditions of such license."

At first reading this seems to mean that American machine tools cannot enter the United Kingdom after Dec. 21. Machine-tool builders feared that this was a means taken to cancel unfilled orders, and there began to arise fears of a temporary demoralization of the machine-tool-building industry.

The excitement was increased by the facts that the Department of Commerce did not have a single shred of information beyond that contained in the text of the telegram, representatives in this country of British machine-buying firms had no advices from their principals at home, and cables to London failed to bring an immediate response.

At the same time it was difficult to believe that the first and easy interpretation could be true. Inquiries for machine tools and queries in regard to deliveries on unfilled orders continued to come in by cable during last week. Not a hint had reached this country from Europe in regard to any change in the war situation which might furnish a reason for the shutting off of the supply of American machines. And further, the condition of the machine-tool-building plants is such that machines in process could easily be diverted to the needs of American buyers or foreign buyers other than the British. Thus there did not seem to be any good reason for giving way to the feeling of alarm that the publishing of the telegram at first aroused.

The wisdom of this attitude is shown by the information contained in two cables received just before we go to press. The first reads: "Certain recognized firms will be licensed to import tools." The second is worded as follows: "Proclamation does not prevent importation by legitimate and established importing business firms who comply with the regulations and are granted licenses. Principal importers report no difficulty will arise from the new conditions and approve them."

From these we understand that the royal proclamation does not prohibit but merely restricts importation. Through certain Government authorized channels—"recognized firms"—machine tools will continue to be imported into the United Kingdom as before. But the speculator and fly-by-night broker are to be eliminated from the business.

This is apparently nothing but a war measure intended to put the incoming machine tools under the direct control of the British Government. This is a natural act of the Ministry of Munitions as a part of the complete mobilization of British industry and manufacturing resources. There seems to be no reason for looking upon it in any other light. It is not a prohibition on importation but a restriction. A little censure can perhaps be properly directed at the editor of the *Commerce Reports* for heading the text of the telegram, as printed, "British Prohibition on Importation of Machine Tools." instead of "British Restriction on Importation of Machine Tools." The word "prohibition" was unfortunately and improperly used and contributed to the unnecessary alarm felt in the industry.

In Russian Machine Shop

So little information has come out of Russia in regard to her machine shops and manufacturing conditions that it can be said Americans know practically nothing of the present-day Russian machine-building industry. For this reason, information brought by Dickerson G. Baker, who is so well known to *American Machinist* readers, is of special interest.

Mr. Baker has just returned to this country after a stay of several months in Russia, during which period he had unusual opportunities not only to observe, but to study the manufacture of small arms and ammunition. He brings facts that completely disprove the common idea that Russia is backward in machinery building and metal manufacture and lacking in skilled mechanics.

Complete proof of the erroneousness of these opinions is contained in the fact that the Russian output of rifles and ammunition per man-hour is equal to the best of the American records. And so highly does Mr. Baker think of Russian mechanics that not only does he believe them to be the equal of Americans, but given a shop equipment for mass production and the choice of operating it in either the United States or Russia, he would choose the latter country today. The Russian mechanic is skillful, intelligent, willing to learn an operation and continue performing it for long periods of time without dissatisfaction, and since vodka has been suppressed, his number of working hours per week averages fully as high as that worked in this country.

Since the opening of the war, there has been a tremendous increase in the size of metal-working plants, particularly those engaged on small arms, rifle and ordnance ammunition. In addition, there has been a great increase in the production of machine tools. The Government has established one machine-tool-building plant that is turning out an excellent product. From a per-

sonal detailed inspection of some of these machines, Mr. Baker is convinced that in accuracy they equal the best of those made in America.

There are some things that Russia has made for her own use and has not bought outside at all. Among these are gages for munitions, and all kinds of cutting tools.

One feature of past conditions in the organization of her metal manufacturing plants has some bearing on the situation today. In the past Russian capitalists have often contracted for complete shop equipments to be furnished, installed and started in operation by a foreign contractor. This practice has meant, in some cases, the building up of factory organizations with aliens in the managerial and executive positions.

Because of her vast resources and the industrial awakening due to war demands, there will be a tremendous opportunity for American engineers, experts in machinery building and men skilled in American methods of operating machine tools in selling their services, and for machine-tool builders in the sale of their output. Just at present there is an insistent demand for machinery for producing the larger sizes of explosive shells—4-in., 6-in. and larger. With this is the demand for all kinds of small tools, including twist drills, reamers and cutters; and like all other countries Russia is suffering from a shortage of high-speed steel.

In addition to her manufacturing problem, Russia faces serious transportation difficulties, and railroad materials and supplies are in great demand.

Wood as a Machine-Shop Material

The article in this issue relating to the manufacture of wooden fuse-hole plugs for projectiles brings up an interesting line of thought for the machine-shop man. Wood has been considered a somewhat crude material that can be worked only to comparatively coarse limits. When the need arises, however, means are found to accomplish things which were formerly deemed impossible, and sometimes the ease with which intelligent effort brings success in such matters is somewhat surprising. There is no particular fuss or any extraordinary measures to be observed in the factory that is doing this work and in which the percentage of rejection due to both incorrect measurements and poor material runs way below what it would be in a metal-working shop for articles subject to similar limits.

One thing that helps very considerably toward the accomplishment of this purpose is the fact that the cutting tools retain their shape, form and keenness during many continuous days of operation. The work, which is run at high speed, is less liable to distortion than is metal of similar proportions, since cutting is much easier and produces less strain, owing not only to the lower tensile strength of the material, but also to the sharpness of cutting angle of the tools, which result in ideal cutting conditions. Given a machine of initial accuracy comparable with metal-turning machines, accurate stops for the tool slides and operators of equal intelligence, it becomes evident that it is really an easier matter to make interchangeable pieces of wood than of metal. The chief likelihod of variation in wooden products comes from the influence of changing atmospheric conditions. In the hard white woods, such as birch, maple and beech, very little change is apt to be occasioned from this source if the wood is properly seasoned before turning.

There are a great many small templates and other pieces of apparatus that in the machine shop are made of metal largely because this happens to be the handiest and most common material. A proper conception of the possibilities of some of the hard white woods as a substitute for the more expensive metals is something to be cultivated by the machine-shop manager as a source of possible economy. When one considers that an expensive bronze plug costing in the neighborhood of 40 or 50 cents is replaced by an equally serviceable wooden plug costing something less than one cent, the possibilities in this line become considerably emphasized.

Simple fixtures and templates that are used but once and then thrown away, and the use of which does not necessitate the employment of metal for strength, should be made of wood. Get the pattern shop busy and let it take some of the load away from the toolroom.

What's the Matter with Our Methods of Threading?

Perhaps there's nothing wrong with our threading methods, but it is at least worth while to inquire into them. They are very fast in many cases, but there is general complaint in regard to inaccuracy.

This is emphasized by the experience of those making munitions of war that require threads. Whether male or female threads seems to make no difference; both, when machine-cut, are equally unsatisfactory to the inspector and his gages.

In nearly every instance where parts are threaded, whether it be primers, fuses or projectiles, the threads have to be finished by hand sizing when they are first machine-cut by the usual tap or die. The taps and dies do not give satisfactorily uniform results when used in automatic or other machines and cannot be depended on to produce an accurate product.

There are probably good reasons for this state of affairs. Experience has shown that the kind of cutting lubricant affects the size of thread, and there is doubtless no mystery about its action. But the fact remains that we can cut cylindrical pieces more uniformly than we can cut threads, and this fact reduces production and increases the cost of the latter by making more operations necessary.

One phase of the question is that nearly all cylindrical surfaces are given a roughing and finishing cut, while the tap or die must produce its thread at one cut. This not only means the removal of considerable metal, and the question of lead, which affects the fit so materially, is to some extent affected thereby. But whatever the cause, there must be a remedy, and the sooner the difficulty is recognized, the better.

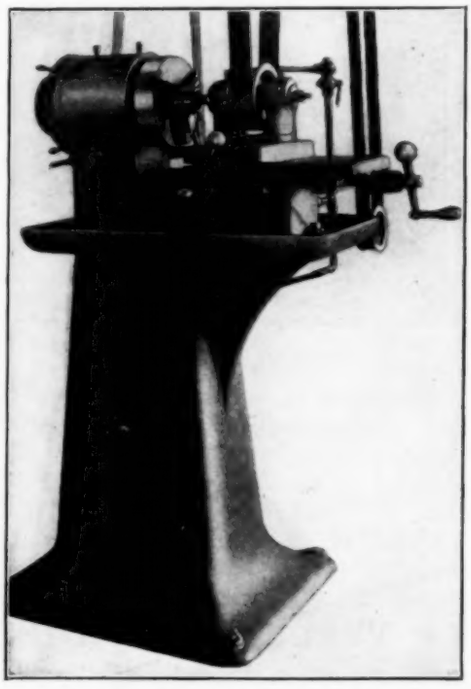
There is no denying that the requirements of inspection for threads are exacting, probably foolishly so in many cases, but this also holds true of cylindrical work. The threading problem can undoubtedly be solved so as to make hand sizing unnecessary, not by the use of special threading machines, but by a study of the problem from the viewpoint of both the tap and die and the machines they are to be used in, especially the latter. It is certainly important enough to study, at any rate.

Shop Equipment News

Internal Thread Miller

In the 3-in. internal thread miller shown the spindle is a large hollow casting running in plain cast-iron bearings. Both spindle and bearings are scraped to each other. In the center of the bearing is a worm gear, which is driven from a worm shaft and pulley, the worm being continually submerged in oil. This is designed to permit a rapid belt speed and to secure the slow rotation desired on the spindle.

The spindle is advanced by means of lead screw and nut. The lead screw is a shell having the desired lead cut upon it, fastened to the exterior of the spindle on the rear end of the main bearing. The lead-screw nut is the ring, or flange, shown with a series of notches around its periphery and three handles around the face of this flange. There is also a small level pawl.; while the spindle is revolving, it passes through the nut and gives the desired advance. After the work is completed the pawl



INTERNAL THREAD MILLER

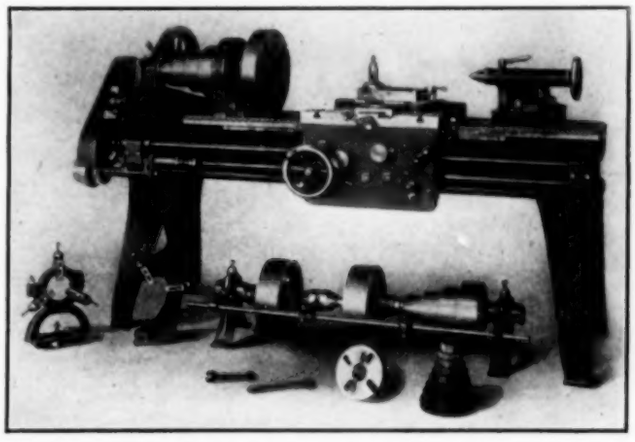
is withdrawn and the lead-screw nut is returned to the starting point by means of the handle shown thereon. The end of the spindle can be provided with a collet chuck, Universal chuck, as shown, or any other device that would lend itself best to the work intended.

The milling spindle, fitted with a 6-in. pulley for a 2½-in. belt, has regular milling-machine type of bearings, the front having a taper that is adjustable centrally for wear. The milling-spindle headstock or housing is scraped to the upper cross-slide and bolted thereto in the form of a swivel, so that should the hole become taper on either end, it can be corrected by swiveling the headstock whatever amount may be necessary.

The machine weighs about 945 lb. and is a recent product of the Automatic Machine Co., Bridgeport, Conn.

Single Back-Geared Lathe

The illustration shows a larger-sized single back-geared engine lathe recently built by the Dalton Machine Co., 1911 Park Ave., New York, N. Y., the smaller



SINGLE BACK-GEARED 14-IN. ENGINE LATHE

models of which have been previously described in detail in these columns.

The general design and construction need little comment. While the machine is listed as a 14-in. swing the actual swing over the shears is 16¼ in. The swing over the carriage is 8 in. and over the compound rest, 3 in. The cross-slide has a travel of 10 in., and the maximum distance between centers is 36 in. The thread-cutting range (including 11½) is 3 to 40; the back-gear ratio 7 to 1. The travel of the tailstock spindle is 5 in.

The machine shown has a 6-ft. bed and weighs 1,850 lb. Other sizes made regularly are 6x30 in. and 11 in. by 5 ft.

Adjustable Flexible Grinder

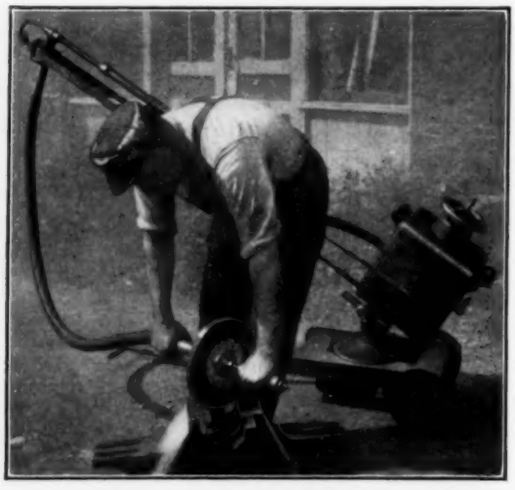
In the flexible grinder shown the motor-shaft combination is mounted on a truck, eliminating the necessity of taking the work to the tool.

The motor is inclosed, with the starting equipment incorporated within the motor frame to secure a compact construction.

In the direct-current equipment the variation in speed is secured by means of a plunger in the pole piece, which operates to change the reluctance of the magnetic circuit. The speed variation permits the use of worn emery wheels down to the minimum, insuring proper cutting speed regardless of size and giving the highest efficiency. The motor is so balanced on the truck that it may be adjusted to the proper angle for all purposes and to meet

all grinding conditions. The weight of the flexible shaft is taken off the operator. The motor shaft combination may be had for any current.

This grinder is also furnished for alternating current, in which case the motor does not regulate. The tool is



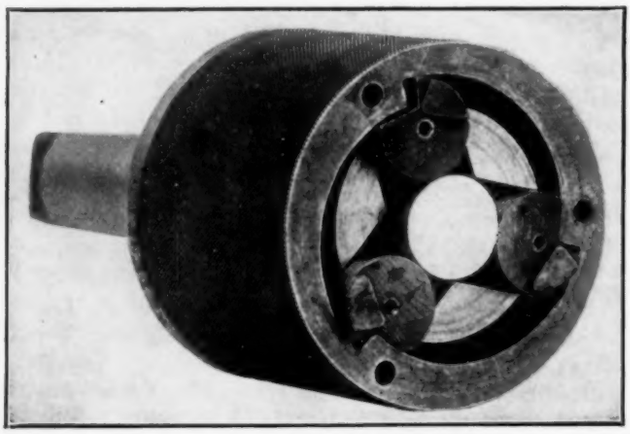
ADJUSTABLE FLEXIBLE GRINDER

built in several sizes, according to the capacity of the emery wheels desired. The wheels may be interchanged with a scratch brush. The machine is the latest addition to the line made by the Stow Manufacturing Co., Binghamton, N. Y.

Automatic Drill Chuck

In the illustration is shown the latest model of automatic drill chuck developed by the Wahlstrom Tool Co., 346 Carrol St., Brooklyn, N. Y., of which the previous forms were described in detail on page 541, Vol. 37, and page 658, Vol. 40.

The absence of all projections is a special feature. The tools are centered automatically and can be changed almost instantly without stopping the spindle. The drill



AUTOMATIC DRILL CHUCK

is put in or removed with one hand while grasping the chuck with the other. The throw of the eccentric jaws has been increased in the improved model so that the range of the chuck shown has been enlarged to accommodate drills from $\frac{3}{8}$ to $\frac{3}{4}$ in. The design of the roller-cam jaws is such as to exert an increased gripping power in direct proportion to the greater drill duty imposed. It will be observed that drills without tangs can be just as effectively held and driven.

The type of chuck shown is made in a number of sizes and in styles for both straight and taper shanks.

Universal Arbor Press

The special feature of the arbor press shown is the V-plate, which consists of a V-shaped slot with a series of holes on both sides.

Any of the holes or any section of the slot can be placed directly under the ram without detaching the

UNIVERSAL ARBOR PRESS

plate from the press, thus making the complete range of the press available without the necessity of extra attachments.

The rack, or ram, is of square section, designed for additional strength and readily adjustable. This press is a recent product of the Special Tool Co., W. Hancock, Mass.

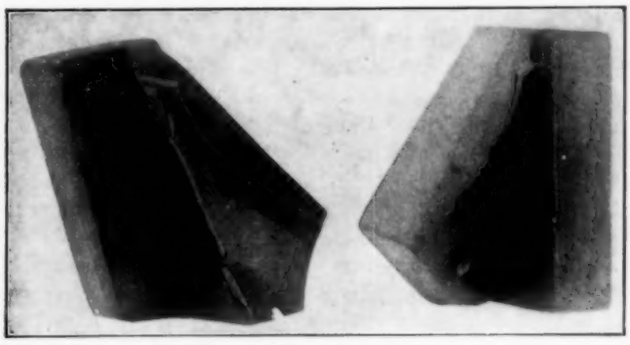
Cast Vanadium-Steel Dies

Cast vanadium carbon dies, of which the illustration is an example, are a recent development of the Sivyer Steel Casting Co., Milwaukee, Wis. They have been designed to replace hammered carbon blocks for a great variety of purposes.

The use of vanadium in cast-steel dies is calculated to obtain the necessary combination of toughness and hardness. The dies can be cast to any desired shape in order to save material. For general drop-forge work it is claimed that the best practice is to cast the dies with the tenons and with the impressions for breakdowns approximately to shape, allowing a small amount for finish. The impression for the die is then sunk in the solid block. For plain forgings the impressions also are

sometimes cast in the dies, allowing some metal for finish. Forming dies for sheet metal are also cast approximately to shape, with some allowance for finishing.

It is claimed that cast vanadium dies when properly annealed by the foundry can be machined without much

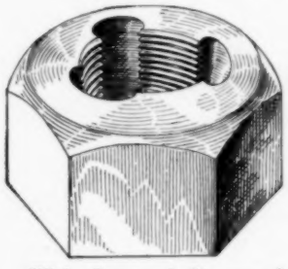


CAST VANADIUM CARBON-STEEL DIES

difficulty. After being machined the general practice is to heat to 1,500 or 1,550 deg. F. and quench in oil for a fairly hard surface and in salt water for a hard surface. In most cases no additional heat-treatment is required; that is, the temper should not be drawn.

Handy Nut Die

Circumstances often arise in connection with driven studs that cause much loss of time owing to the exposed threads becoming battered.



The nut die shown was devised to readily remedy broken or obstinate bolt threads in inaccessible places. It is also available for cutting new threads. Sets for U. S. Standard and A. L. A. M. threads are made by the Mummert-Dixon Co., Hanover, Penn.

This form of die can be used in connection with any common form of wrench, a socket wrench being preferable for this purpose.

Multiple Drilling Machine for Heavy Pipe Flanges

The machine shown was especially designed for the National Transit Co., Oil City, Penn., for heavy drilling, such as the flanges shown. It has 12 spindles and is 10 in. higher than is usual. The special feature is the center feed, the feeding pressure being in the center of the head, directly over the center of the drill layout, to eliminate the tendency of the head to spring away from the guides on the post under heavy duty. The head is 40 in. long, giving a long bearing on the post. The gear chest is over the top of the head, giving extremely long spindle connections that make a very slight angle to the joints.

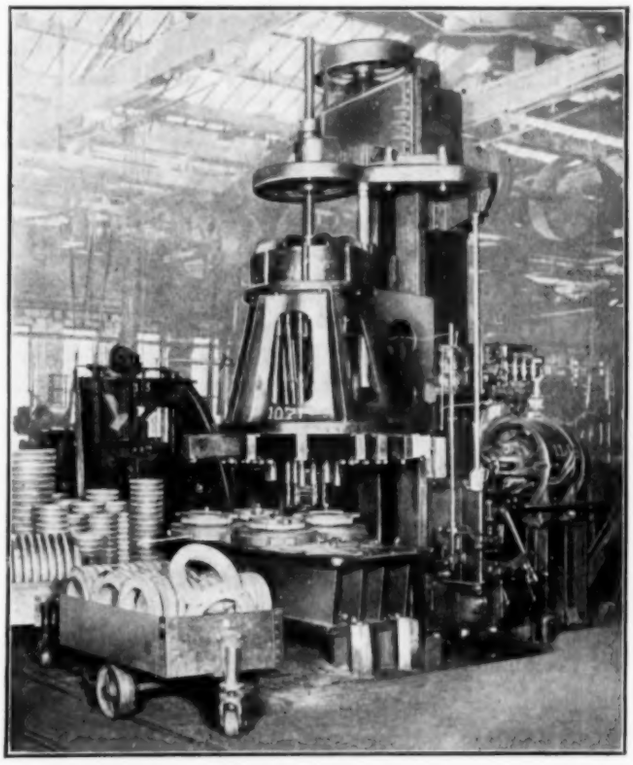
The drive is by countershaft to cone pulley, or by motor to the same shaft, through one pair of bevel gears and two pairs of spur gears to the spindle gear in the head, making a very direct drive. The bevel gears are of steel; the gears at the top of the post are of cast iron, and the gears in the head are of steel. The driving shaft to the head is 3¼ in. in diameter and runs nearly at the same speed as the drills.

The feed screw is 3 in. in diameter, 2½-in. pitch, acme thread, and is fixed in the head, the nut being rotated. This nut is of bronze and the lower 10 in. is threaded, the upper end bored slightly larger than the screw, giving an oil pocket that insures good lubrication. This nut has a solid head on the lower end to take the feeding thrust and a large nut and check nut at the upper end to take the weight of the head, with a large ball thrust bearing at each end.

There are two changes of feed, obtained by shifting the clutch lever on the lower part of the feed gear box.

Feed is taken from the main cone shaft through spur gears (cloth pinion) and through change gears to the worm and worm gear on the vertical shaft, through the feed gear box and spur gear near the top of the post to the feed nut.

The feed lever has a catch that locks it in place when the feed is thrown in and is released by the knock-off



SPECIAL MULTIPLE DRILLING MACHINE

rod, the rod first compressing a spring on top of the feed lever. When the catch is released the feed clutch is thrown out, the quick-return clutch is thrown in and the head is automatically raised to the upper position. Quick motion downward is by reversing the quick-motion lever.

Roller bearings are used at both ends of the cone shaft and the vertical shaft in the post. All other bearings are bronze bushed.

The machine is usually equipped with 16 spindles for 1½-in. holes in cast iron, but it is always built to order, and with 2½-in. joints would carry twenty 1¼-in. drills in cast iron. The shipping weight is 29,000 lb., and it is driven by a 35-hp. motor. It is built by the Baush Machine Tool Co., Springfield, Mass.

Thirty-Sixth Annual Meeting of Mechanical Engineers

(Continued from page 1090)

Wednesday's Machine-Shop Session

The machine-shop session on the afternoon of Dec. 8 was well attended. Luther D. Burlingame presented a paper on "Automatic Mechanical Control of Lathes and Screw Machines," which pointed out the leading methods employed for this purpose. The essential features of control were divided into five classifications: spindle drives; means of inserting and removing work; feeding mechanisms; indexing mechanisms; controlling means for the various mechanisms. The various means of securing these controls were shown by examples from well-known machines.

It was shown that in spite of such drawbacks as increased initial investment, greater danger of breakdown and greater skill required for successful operation, as well as more expensive equipment standing idle, the use of automatics is constantly increasing.

Discussion as to whether speeds and feeds could be higher on hand-operated machines than on automatics found R. E. Flanders in the affirmative and J. P. Neff in the negative.

C. M. Conradson submitted a discussion pointing out the possibilities of both pneumatic and hydraulic feeds, which included the work done by Church at the Waltham Watch Co., by Hartness, in Springfield, Vt., and by his machines of more recent date.

The paper by L. C. Brooks, on "Electric Operation and Automatic Control for Machine Tools," took up the essential features of recent developments and brought out a lively and interesting discussion by both electrical and mechanical engineers. The advantages of the manual and automatic controls were forcibly brought out, the use of a belt between the motor and the machine as a safety valve having its advocates from some of the machine builders.

The report on the safety code for the use and care of abrasive wheels was also considered and discussed. This is an attempt to formulate a code which shall standardize proper safety requirements that will meet the various state laws and also act as a guide for such sections as have not yet adopted rules for this purpose.

A Symposium on Industrial Safety

The Industrial Safety session, the first of its kind, was held on Friday. The first three papers were contributed by the subcommittee on protection of industrial workers, and the fourth by the Philadelphia local committee.

In his paper on "Standardization of Safety Principles," Carl M. Hansen pointed out that as engineers are the designers of machinery, they are thereby responsible for the hazards of industry resulting therefrom. This makes it a part of their duty so to design machines as to afford safety to the operator, instead of leaving the question of accident prevention and compensation to others. Mr. Hansen advocated a thorough standardization of the principles involved in making machines safe without naming specific devices except where it is absolutely necessary.

In the discussion which followed Professor Hutton suggested that one of these principles should be the use of interlocking devices, or those which require the use of both hands to operate the machine. Mr. Barr considered that while the specifications might allow considerable leeway as to method, they should be very rigid regarding the functions desired, and that safety should be an essential element of good design in all machines.

The paper on "Modern Movement for Safety from the Standpoint of the Manufacturer," by Melville W. Mix, pointed out that mechanical safeguards are not sufficient in themselves but that the coöperation of the workers must be secured. This is only partly possible unless the heads of the business are personally interested. He pointed out that the average man will observe precautions for the benefit of the gang or the department which he would not observe to guard himself against minor accidents. This point was enlarged upon by several who took part in the discussion, and it was considered an essential part of a safety-first campaign to secure this spirit among the workmen. Mr. Barth felt that some safety devices tended to make men careless and that if more factory executives developed their backbone it would be better for all concerned. The latter was agreed to by those who followed, but the majority seemed to feel that the most thorough safeguarding did not make for carelessness if the proper spirit was encouraged. It was pointed out that a large percentage of the accidents occur from the use of new machines, owing to their dangers not being appreciated. For this reason it was advocated that all dangers which could be foreseen should be codified and brought to the attention of all those who are likely to be in the danger zone.

Far-Reaching Effects of Safety

Doctor Patterson, who conducts the safety work for several large firms in Philadelphia, gave figures as to the specific savings due to this work. Accidents have been reduced from an average of 266 per month to 40, and the lost time per month from 1,000 to 40 days.

"The Attitude of the Employer Toward Accident Prevention and Workmen's Compensation," by W. H. Cameron, was a particularly good review of the growth of safety work in this country, while "Industrial Safety and the Principles of Management," by W. P. Barba, pointed out some of the economic advantages of the safety campaign. It was stated that investigation showed an average cost of $150 per employee before he became productive, and that during 1914 accidents cost employers in a score or more of the larger industries in Pennsylvania over $1,000,000; 38,126 men were thrown out of work, and each man lost an average of $27.50.

Professor Williston gave some experience as to the distinct advantage of individual instruction of workmen concerning accident hazards. This is done in the case he mentioned by issuing to a man going to work on a new machine effective instruction sheets concerning the safe operation of each machine. Before he is allowed to operate the machine, the man is examined to see if he understands the instruction given, and though this might seem like considerable delay, it has worked out very satisfactorily as to both production and safety.

Mr. Boehm seconded this with the experience of the Fidelity and Casualty Co. in personal instruction concerning the safety of machines insured. He, in addition to many others, also advocated codifying the principles of safety devices so as to make their universal adoption easier in every way. Secretary Rice pointed out that the technical and vocational schools are excellent fields

for the propagation of the safety idea, and that we could all assist by calling the attention of instructors and others to machines which should be thoroughly guarded. Doctor Godfrey, of the Drexel Institute, told of its work along this line and stated that preparations are now being made to equip every machine in the institute with the best possible safety device to be obtained.

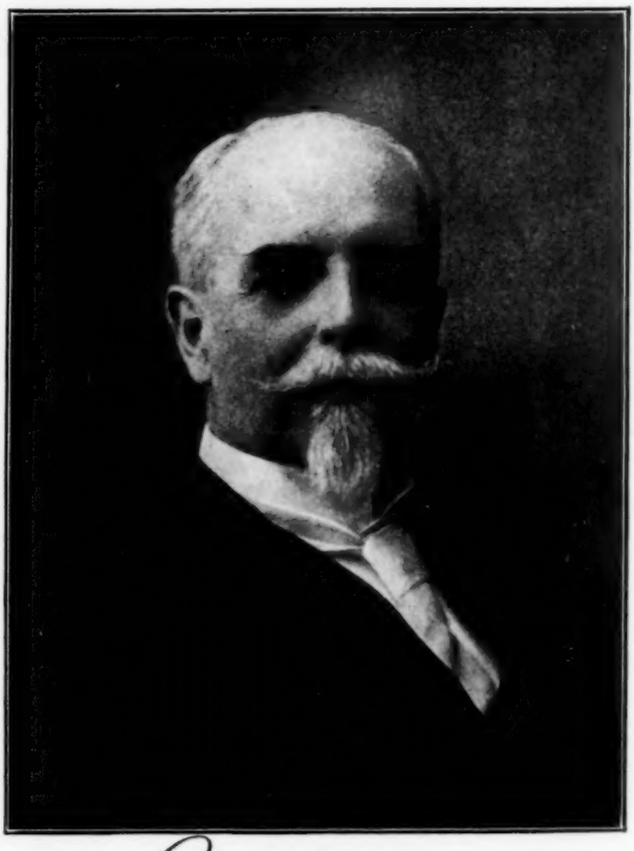
This closed the technical session, Mr. Brashear, the retiring president, making a few personal remarks on the work of the past year.

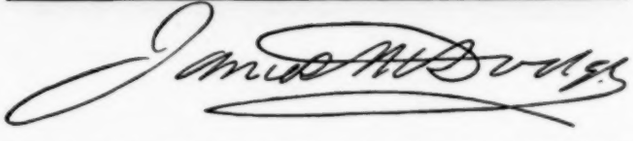
The newly elected officers are: President, Dr. D. S. Jacobus; vice-presidents, William B. Jackson, J. Sellers Bancroft, Julian Kennedy; managers, John H. Barr, John A. Stevens, H. de B. Parsons; treasurer, William H. Wiley.

James Mapes Dodge

In the passing of James Mapes Dodge, chairman of the board of directors of the Link-Belt Co., whose death on Dec. 4, 1915, was briefly announced in last week's issue, the world lost a commanding figure in engineering, invention and the development of industrial ideals.

Mr. Dodge was born at Waverly, N. J., in 1852. His maternal grandfather, James J. Mapes, was an eminent chemist and scientist. His mother, Mary Mapes Dodge, was widely known through her editorship for many years of the juvenile magazine, "St. Nicholas." Mr. Dodge was for three years a





student at Cornell University; then he spent a year at Rutgers College, New Jersey, where he took a special course in chemistry. His early engineering work was in the field of shipbuilding. Starting in as an ordinary workman at the famous old shipyards of John Roach, at Chester, Penn., he became at the end of three years superintendent of erection.

In Chicago about 1880 Mr. Dodge became acquainted with William D. Ewart about the time that the latter had invented and patented a new type of sprocket-chain transmission, using separable links. Mr. Dodge joined Ewart and his associates in the commercial development of this invention, and it determined his future business career.

At the time of the Ewart invention the sprocket wheel and chain, although an old device for the transmission of motion, was hardly used in machine construction or engineering. Mr. Dodge's inventive genius found full scope in the new industry in the development of various devices intended to utilize the chain transmission. The application of chain transmission to large power installations led to the formation, in 1888, of the Link-Belt Engineering Co., where under Mr. Dodge's direction a strong engineering and scientific organization was built up.

In 1889 Mr. Dodge brought out his now well-known system of anthracite coal storage, using the Link-Belt conveyor to deliver the coal in great conical piles. A separate organization, the Dodge Coal Storage Co., was formed to exploit this invention. The extent of Mr. Dodge's original work may be judged by the fact that he took out over a hundred United States patents on his inventions.

In the later years of his life Mr. Dodge's interest in scientific management, as enunciated by Frederick W. Taylor, became one of the movement's chief bulwarks. He was the first manufacturer to adopt in its entirety the Taylor system of shop management. To his many contributions on the subject, readers of the "American Machinist" need no introduction. His conception of the proper relationship between employer and employee is strikingly presented in his testimony before the United States Commission on Industrial Relations in 1914, when he stated: "My personal relations with my employees come near to the point where they call me 'Jim' instead of Mr. Dodge, and my door is always open to them."

In 1913, at the time of the visit of the American Society of Mechanical Engineers in Germany as the guest of the Verein des Deutscher Ingenieure, he prepared the American paper on the subject of industrial management.

The difficulties and anxieties of the period when scientific management was being installed in his shop in Philadelphia will never be known. At the outset Mr. Dodge stood alone in his determination to apply the Taylor principles. Thus, success or failure of this attempt really meant his own further success or perhaps business disaster. In two articles published in the "American Machinist" this year (pp. 281 and 377, Vol. 43), covering the beginning of the use of high-speed steel and the first installation of scientific management, he gave a little insight into the early anxieties of these days and then the final success of the pioneer attempt.

The charm of his personality will live for many years in the memories of his friends. He was always genial, kind and keenly interested in everything about him, with a fund of good humor and a store of telling anecdotes that made him the center of whatever group he was in and the life of whatever social occasion he attended.

In 1913 Stevens Institute of Technology conferred upon him the honorary degree of Doctor of Science. Throughout his long residence in Philadelphia he was constantly a prominent figure in civic affairs. He was formerly president of the Public Service Committee of 100 of that city and a member of the Committee of 70. He was a member of the Union League, Corinthian Yacht Club, Germantown Cricket Club and the Engineers' Club of Philadelphia. He was also a member of the Engineers' Club of New York. In 1892 he became a life member of the Franklin Institute, being elected vice-president in 1903. He was a member of the board of managers and first vice-president of the institute, as well as a member of several of its important committees. He was the first president of the Society to Promote the Science of Management.

Mr. Dodge was among the best-known members of the American Society of Mechanical Engineers. He joined the society in 1884, only four years after its organization. He was elected one of the managers of the society in 1891, was a vice-president in 1902 and was elected to the presidency in 1903. He is survived by his wife, two daughters and two sons, Kern Dodge, a consulting engineer, Philadelphia, and Karl Dodge, of Chicago.

The Use of Aluminum has received a great impetus from its suitability to the construction of air craft. It is also valuable as an explosive. "Ammonal" consists of ammonium nitrate and finely divided aluminum, according to an article in "Nature." It is a disruptive explosive not suitable for propulsion but excellent for filling explosive shells. The United States and Canada have produced about half of the world's supply, the rest coming from France, England and Switzerland.

Prices--Materials and Supplies

PIG IRON—Quotations were current as follows at the points and dates indicated:

	Dec. 10, 1915	Nov. 12, 1915	Dec. 10, 1914
No. 2 Southern Foundry, Birmingham	$14.00	$13.00	$9.75
No. 2X Northern Foundry, New York	18.50	16.75	14.00
No. 2 Northern Foundry, Chicago	18.00	17.00	13.00
Bessemer, Pittsburgh	19.45	17.45	14.70
Basic, Pittsburgh	18.45	16.45	13.45

METALS—Below are the present quotations with a comparison of a month and year ago:

MISCELLANEOUS METALS—NEW YORK

	Dec. 10, 1915	Nov. 12, 1915	Dec. 10, 1914
	Cents per pound		
Copper, electrolytic (carload lots)	19.75	18.50	13.00
Tin	37.25	41.00	33.50
Lead	5.25	5.15	3.80
Spelter	15.00	16.00	5.50
Copper sheets, base	25.00	23.25	18.00
Copper wire (carload lots)	28.25	28.25	14.25
Brass rods, base	27.25	26.25	13.00
Brass pipe, base	32.00	31.00	15.25
Brass sheets	27.25	26.25	13.25
Solder ½ and ¼ (case lots)	23.50	23.37½	19.88

MONEL METAL—The following prices hold:

Size, In.	Mill Lengths 8 Ft. and Over: 10,000 Lb. of a Size and Over	6,000 Lb. of a Size and Over	2,000 Lb. of a Size and Over	500 Lb. of a Size and Over	Less than 500 Lb. of a Size and Over
Rounds—Squares	Cents per Pound				
1/16 — 3/32	31.50	32.00	32.50	33.00	36.00
1/8 — 7/32	31.25	31.75	32.25	32.75	35.75
¼ to 1¼	31.00	31.50	32.00	32.50	35.50
1⅜ to 2¼	31.75	32.25	32.75	33.25	36.25
Rounds 3 to 3 1/16	32.50	33.00	33.50	36.00	37.00
Squares 3	32.50	33.00	33.50	36.00	37.00
Rounds 3⅛ to 3⅜	32.25	32.75	33.25	35.75	36.75
Squares 3 1/16 to 3⅜	32.25	32.75	33.25	35.75	36.75
Rounds—Squares 4 to 4⅜	33.00	33.50	36.00	36.50	37.50
5 to 6⅜	36.00	36.50	37.00	34.50	38.50
7	36.50	37.00	37.50	38.00	39.00
Flats	32.50	33.00	33.50	36.00	37.00

Flats not rolled wider than 6 in. or less than ¼ in. thick.
Hexagon Bars two cents (2c) per pound over corresponding size of round rods.

For cutting to any specified length not shorter than 1 ft. add 1c. per lb.

The scrap allowance is 18c. per lb. delivered at works.

SAL SODA remains unchanged at 1c. per lb. in bbl. lots in New York. The price in Philadelphia is 75c. per 100 lb.

ROLL SULPHUR in 360-lb. bbl. sells in New York at $2.15 per 100 lb.

ZINC SHEETS—The following prices prevail:

Quantity	Cents per Lb.
Carload lots, f.o.b. mill	22.00
In casks, New York	22.50
Broken lots, New York	23.00

STANDARD PIPE—On carload lots f.o.b. Pittsburgh the following discounts hold:

	Black	Galvanized
¾ to 2-in. steel, butt welded	78%	63½%
2½ to 6-in. steel lap welded	77%	62½%
7 to 12-in. steel lap welded	75%	58½%

At this rate prices are as follows:

Diameter	Cents: Black	Cents: Galvanized	Diameter	Cents: Black	Cents: Galvanized
¾-in.	2.53	4.19	5-in.	34.04	55.50
1-in.	3.74	6.30	6-in.	44.16	72.00
1¼-in.	5.06	8.39	7-in.	59.50	98.77
1½-in.	6.05	10.02	8-in.	62.50	$1.03
2-in.	8.15	12.55	9-in.	86.25	1.43
2½-in.	13.45	21.92	10-in.	$1.03	1.70
3-in.	17.59	28.68	11-in.	1.16	1.92
4-in.	25.07	40.87	12-in.	1.27	2.10

NAILS—Wire nails f.o.b. Pittsburgh sell at $2; galvanized 1 in. and longer, $4, and shorter, $4.50. These prices are to regular customers and delivery is made at the mill's convenience.

CARRIAGE BOLTS—On ⅝ by 6 in. and smaller 70% off list is allowed; for larger and longer sizes, 60 and 5% off list is charged. At this rate the prices per 100 are shown below:

Length	Diameter: ¼	5/16	⅜	7/16	½	⅝	¾
1½ in.	$0.30	$0.42	$0.57	$0.84	....	....	....
2 in.	.33	.46	.62	.91	....	....	....
2½ in.	.36	.49	.67	.99	$1.24	$2.19	$3.15
3 in.	.39	.53	.71	1.06	1.34	2.33	3.42
3½ in.	.42	.56	.76	1.14	1.54	2.47	3.61

MACHINE BOLTS—From New York warehouse, on sizes from ⅜ in. by 4 in. and smaller 70 and 5% off list is discounted; for larger and longer sizes 65% is allowed. These quotations are for bolts having square heads and square nuts. At this rate the prices per 100 are shown below:

Length	Diameter: ¼	⅜	½	¾	⅞	1 In.
1½ in.	$0.48	$0.68	$1.82	$2.70	$3.68	$5.29
2 in.	.51	.73	1.95	2.89	3.92	5.60
2½ in.	.53	.76	2.09	3.08	4.17	5.92
3 in.	.55	.82	2.22	3.27	4.41	6.23
3½ in.	.58	.87	2.35	3.47	4.66	6.55

WROUGHT WASHERS—From New York warehouse the present quotation is $5 from list price. At this rate the following prices hold:

Diameter, In.	Price per 100 Lb.	Diameter, In.	Price per 100 Lb.
5/16	$9.00	1½	$4.30
⅜	7.20	1¾	4.20
⅞	6.40	2	4.10
1	5.50	2¼, 2½, 2¾	4.00
1¼	4.80	3, 3¼, 3½	4.20
1⅜	4.40	3¾, 4, 4¼, 4½	4.50

RIVETS—Steel tank rivets ⅞ and smaller sell at 70 and 10% off list. On copper rivets 40 and 5% off list is asked. On burs 20% off list is quoted.

NUTS—On hot pressed square nuts $4 off list is allowed and on hexagon $4.50. At this rate, the following prices hold:

Hot Pressed Square: Short Diam.	Per 100 Lb.: Blank	Tapped	Hot Pressed Hexagon: Short Diam.	Per 100 Lb.: Blank	Tapped
½	....	$11.00	½	....	$17.00
9/16	$7.00	8.50	9/16	....	10.60
⅝	5.00	5.90	⅝	$5.70	6.70
⅞	4.00	4.70	1¼	4.50	5.10
1¼	3.50	3.90	1⅛, 1⅝, 2	4.40	5.00
1⅛, 1⅝, 1⅞, 2	3.40	3.80	2⅛	4.50	5.20
2⅛	3.50	4.00	2⅝	4.80	6.60
2⅝	3.80	4.40			

On semifinished nuts 75% off list is allowed.

SEAMLESS DRAWN TUBING—The base price is 33c. for brass and 33c. for copper. For immediate stock shipment 2c. is added, which gives the following quotations in cents per lb.:

Diam., In.	Brass	Copper	Diam., In.	Brass	Copper
¾ to 3	35.00	35.00	5	41.50	41.00
3½	36.50	36.00	6	42.50	42.00
4	37.50	37.00	7	44.50	44.00
4½	39.50	39.00	8	46.60	46.10

COPPER BARS—The base price is 27½c. per lb.

STEEL SHEETS FROM JOBBERS' WAREHOUSE, NEW YORK

	Dec. 10, 1915	Nov. 12, 1915	Dec. 10, 1914
	Cents per pound		
No. 28 Black	3.15	3.00	2.60
No. 26 Black	3.05	2.90	2.50
Nos. 22 and 24 Black	3.00	2.85	2.45
Nos. 18 and 20 Black	2.95	2.80	2.40
No. 16 Black	2.90	2.70	2.35
No. 14 Black	2.80	2.60	2.25
No. 12 Black	2.70	2.55	2.20
No. 28 Galvanized	5.25	4.75	3.50
No. 26 Galvanized	4.95	4.45	3.20
No. 24 Galvanized	4.80	4.30	3.05

STEEL SHAPES FROM JOBBERS' WAREHOUSE, NEW YORK

	Dec. 10, 1915	Nov. 12, 1915	Dec. 10, 1914
	Cents per pound		
Steel angles base	2.40	2.20	1.85
Steel T's base	2.45	2.25	1.90
Machinery steel (bessemer)	2.40	2.15	1.85

The above prices are for angles 3 in. by ¼ in. and larger and tees 3 in. and larger.

BABBITT METAL—Best grades are selling from 55 to 60c. per lb. Ordinary commercial grades command 25 to 30c. per lb.

WELDING MATERIAL (SWEDISH)—Prices are as follows:

Welding Wire	Cents per Lb.
3/8, 11/32, 5/16, 1/4, 7/32, 3/16	8.50
No. 8, 9/32 and No. 10	9.25
1/8	10.00
No. 12	11.00
5/32, No. 14 and 1/16	12.00
No. 18	14.00
No. 20	16.00

Special Welding Steel	
1/8	33.00
5/32	30.00
3/16	28.00

Cast-Iron Welding Rods	Cents per Lb.
1/4 by 19 in. long	22.00
5/16 by 12 in. long	26.00
5/16 by 19 in. long	20.00
1/2 by 21 in. long	20.00

Vanadium Wire in Coils or Sticks	
1/2	15.50
7/16	15.00
3/8	14.00
5/16	12.00
1/4 and larger	11.00

The above prices are subject to change according to quantity and shipment desired.

SWEDISH (NORWAY) IRON—This material sells at $4.25 per 100 lb. f.o.b. New York.

ANTIMONY—For spot delivery on Chinese and Japanese brands, duty paid, 39c. per lb. is asked.

COLD DRAWN STEEL SHAFTING—To consumers requiring fair-sized lots the price is unchanged at 35% off list.

OLD METALS—The following are the dealers' purchasing prices in New York:

Copper	Cents per Lb.
Heavy and crucible	16.50
Heavy and wire	16.00
Light and bottoms	14.00
Lead	
Heavy	4.50
Tea	4.25

Brass	Cents per Lb.
Heavy	11.50
Light	9.50
No. 1 yellow rod turnings	12.00
No. 1 red turnings	11.00
Zinc	10.00

COKE—Below are the prices per net ton at ovens, Connellsville, and cover the past four weeks:

	Nov. 20 1915	Nov. 27 1915	Dec. 4 1915	Dec. 11 1915
Prompt furnace	$2.25	$2.15@2.25	$2.15@2.25	$2.15@2.25
Prompt foundry	2.90@3.15	2.90@3.15	2.90@3.25	2.90@3.25

COTTON WASTE—White cotton waste at New York sells at 6½ to 9½c. per lb., and colored mixed at 4½ to 8c.

OILS—Prime winter lard oil sells at 92@96c. per gal. in 5-bbl. lots; cottonseed crude, f.o.b. mill, 55c.; and linseed, raw, in carload lots, at 61c.

New and Enlarged Shops

If you are in need of machinery or supplies, the first thing to do is to consult the Buying Section. If you cannot find just what you want, send us particulars, and we will be glad to publish it free of cost, thus putting you in touch with reliable manufacturers.

METAL WORKING

NEW ENGLAND STATES

An addition is being built to the machine shop of the Cushman-Hollis Co., manufacturer of shoes, 209 Court St., Auburn, Maine.

Fire, Dec. 5, damaged the Princeton Garage, Allston, Mass. Loss, $35,000.

The C. H. Cowdry Machine Works, Fitchburg, Mass., is building a two-story, 50x84-ft. factory on Gas St.

The Newton Manufacturing Co., Lowell, Mass., is equipping the plant of the old Atherton Manufacturing Co., at Atherton, Mass., for the manufacture of war munitions.

We have been informed that work will soon be started on the construction of a machine shop for Y. Q. Der Bab, 212-218 Broad St., Lynn, Mass. Noted Nov. 25.

We have been informed that the garage of the Foster-Smith Co., Mathewson St., Providence, R. I., recently damaged by fire, will be rebuilt. H. P. Peirce is Mgr. Noted Dec. 2.

The H. B. Smith Machine Co. is constructing additions to its carpenter and machine shop at Westfield, Mass.

The Hartford Special Machinery Co., Hartford, Conn., has acquired a site at Woodland St. and Homestead Ave. upon which it plans to build a factory.

The Stamford Rolling Mills, Springdale, Conn., is building a factory at Springdale, and has had plans prepared for another factory which will be constructed shortly.

Richards & Co., manufacturer of tools, will build a 93x186-ft. addition to its plant at Stamford, Conn.

Watson & Doolittle, Elm St. and St. John Pl., Stamford, Conn., will soon be in the market for machinery for a garage. Noted Dec. 2 and 9.

MIDDLE ATLANTIC STATES

The contract will soon be awarded for the construction of a garage for Charles M. Peabody, 588 Main St., Buffalo, N. Y. Estimated cost, $20,000.

The Hoevel Manufacturing Corporation, Hornell, N. Y., recently incorporated, will establish a plant for the manufacture of sand blast machines, foundry equipment, etc. F. W. Weiss, 96 Clove Rd., New Rochelle, is interested.

The New York Central R.R., New York, N. Y., and the Baltimore & Ohio R.R. Co., Baltimore, Md., are in the market for a large number of tools. S. B. Wight, New York, N. Y., is Pur. Agt. of New York Central R.R. and E. H. Bankard, Baltimore, Md., is Pur. Agt. of Baltimore & Ohio R.R. Co.

Bids are being received by Amelia D. Feldus, 251 Stuyvesant Ave., New York, N. Y. (Borough of Brooklyn), for a one-story, 50x125-ft. garage. Estimated cost, $12,000.

Bids are being received by Simon Hock, 847 Gates Ave., New York, N. Y. (Borough of Brooklyn), for a one-story, 50x100-ft. garage. Estimated cost, $10,000.

Bids are being received by William P. Moore, 69 Pennsylvania Ave., New York, N. Y. (Borough of Brooklyn), for a one-story, 74x110-ft. garage. Estimated cost, $10,000.

The contract has been awarded for the construction of two additions to the plant of the T. H. Symington Co., Leighton Ave. and Crouch St., Rochester, N. Y., manufacturer of railway specialties.

Plans are being prepared for a two-story, 100x100-ft. garage at Woodbury, N. Y., for Otto H. Kahn, 52 William St., New York, N. Y.

The Athenia Steel Co., 135 William St., New York, N. Y., has awarded the contract for the construction of four factory buildings at Athenia, N. J.

The Miller Lock Co., Frankford, Penn., will build a 100x206-ft. machine shop.

George F. Everhart, Gettysburg, Penn., will build a three-story, 51x180-ft. garage. Estimated cost, $20,000.

The contract has been awarded for the construction of a four-story, 89x98-ft. electric truck shop at 15th and Garden St., Philadelphia, Penn., for the Baldwin Locomotive Works. Noted Dec. 2.

Plans prepared by W. E. S. Dyer, Land Title Bldg., Philadelphia, Penn., for an addition to the plant of Baxter, Kelly & Faust, manufacturer of plumbing supplies, on Arbor St., Philadelphia, to be used as a machine shop. Estimated cost, $1,000.

Henry Disston & Sons, Inc., manufacturer of saws, will build a 50x361-ft. addition to its plant on Tacony St., Philadelphia, Penn.

The Mershon Patent Grate Co., Philadelphia, Penn., will build a three-story, 21x60-ft. factory at 1604 North Carlisle St., Philadelphia.

Fire, Dec. 5, damaged the plant of the Pittsburgh Forge and Knife Co., Belmont and Chateau St., Pittsburgh, Penn. Loss, $5,000.

The Bethlehem Steel Co., South Bethlehem, Penn., will rebuild machine shop No. 4, recently destroyed by fire with a loss of $3,000,000. Noted Nov. 25.

Bids will be received by Bureau of Supplies and Accounts, Navy Dept., Washington, D. C., until 10 a.m., Dec. 21, for furnishing machine tools under Schedule No. 9051 as follows: Class 41, 1 universal saw, 16-in., motor driven; class 42, 1 single surfacer, motor driven; class 43, 1 band saw, bevel, futtock, 38-in. motor drive, class 44, 1 band saw, 36-in. direct connected, motor driven; class 45, 1 drill press, 21-in. motor driven, to be delivered at Navy Yard, Portsmouth, Va.

SOUTHERN STATES

E. J. Ward, Camden, Ala., is in the market for second-hand drill press, lathe, and shaper.

The Benjamin J. Glazier Realty and Engineering Co., Chicago, Ill., plans to build a shipbuilding and repair plant on Blakeley Island, Mobile, Ala. Estimated cost, $5,000,000.

A garage will be constructed at Chattanooga, Tenn., by the Hamilton Motor Car Co. Estimated cost, $20,000.

J. B. Palmer will build a garage and equip a repair shop at Nashville, Tenn.

The contract has been awarded for the construction of a two-story, 70x127-ft. garage at Glasgow, Ky., for the Glasgow Motor Car Co. Estimated cost, $14,000. Noted Oct. 28.

The contract has been awarded for the construction of a 83x96-ft. garage at Harrodsburg, Ky., for the Ft. Harrod Garage Co. Estimated cost, $10,000.

MIDDLE WEST

The Canton Drop Forge and Mfg. Co. is building an addition to its plant at Canton, Ohio, to be used as a machine shop.

The contract has been awarded for the construction of a one-story, 200x200-ft. factory at Carthage, Ohio (Cincinnati post office) for the Hess Spring and Axle Co. Estimated cost, $40,000. Noted Nov. 18.

The Buckeye Foundry Co., Cincinnati, Ohio, contemplates the construction of a one-story, 45x182-ft. foundry building at Queen City Ave. and Buck St. Estimated cost, $4,300.

A factory will be constructed on the site of the Viaduct power building, Washington and Center St., Cleveland, Ohio, which was recently destroyed by fire with a loss of $50,000, by W. J. Strangward, of the Walworth Run Foundry Co., Cleveland.

The contract has been awarded for the construction of a factory on Ivanhoe Rd., Cleveland, Ohio, for the White Co., manufacturer of automobiles.

The Apple Automobile Co., Dayton, Ohio, will build a four-story, 100x150-ft. factory.

The Davis Sewing Machine Co. will enlarge plant at Dayton, Ohio.

The Columbia Steel Co., recently incorporated by East Liverpool and Pittsburgh capitalists, has purchased a site near the Ohio-Pennsylvania line and the Ohio River, East Liverpool, Ohio, on which it will build a plant. Estimated cost, $600,000.

The Peters Cartridge Co., Kings Mills, Ohio, has awarded the contract for the construction of a four-story, 65x416-ft. factory. Estimated cost, $250,000. F. C. Tuttle, 1701 First National Bank Bldg., Cincinnati, Secy. Noted Dec. 9.

The Mansfield Sheet and Tin Plate Co., Mansfield, Ohio, will enlarge and improve its plant at Mansfield. Estimated cost between $50,000 and $75,000.

The American Rolling Mill Co., is building a 50x150-ft. addition to its East Side plant at Middletown, Ohio. Noted Dec. 2.

Work will be started early next year on the construction of a four-story, 300x300-ft. addition to the plant of the Robbins & Myers Co., Springfield, Ohio, manufacturer of electric motors, generators and fans. Estimated cost, $200,000. Noted Dec. 9.

The Ward Nail Co., Struthers, Ohio, has increased its capital stock from $50,000 to $100,000 and will install additional equipment to increase the capacity of its plant.

The Cadillac Automobile Co. is having preliminary plans prepared by J. E. Kopf, Arch., for a three-story garage at Indianapolis, Ind. C. F. Eckler, 500 Capitol Ave., Indianapolis, Mgr.

A. Hirschburg, Shelbyville, Ind., will build a two-story, 32x150-ft. garage.

The Enterprise Brass Works, Muskegon Heights, Mich., is building a two-story, 80x150-ft. factory. Estimated cost, $15,000.

The Nufer-Cedar Co., Whitehall, Mich., has awarded the contract for the construction of a box factory and power house. Estimated cost, $35,000.

The Burgess-Norton Co., manufacturer of hardware specialties, contemplates building an addition to its plant at Aurora, Ill.

The Illinois Malleable Iron Co., is building an addition to its plant at 1850 North Paulina St., Chicago, Ill., and also contemplates another addition. Noted Dec. 9.

The Inland Steel Co., Chicago, Ill., has awarded the contracts for several additions to its plant.

Plans have been prepared for enlarging the roundhouse and building an addition to the tool house of the Illinois Central R.R., Freeport, Ill. Estimated cost, $30,000. A. S. Baldwin, Chicago, Ch. Engr.

The Western Manufacturing Co. will construct a plant at Springfield, Ill., for the manufacture of enameled and aluminum ware.

Plans are being prepared by Foeller & Schober, Arch., for an addition to the plant of the Green Bay Barker Co., Green Bay, Wis., manufacturer of knife barkers and paper mill equipment. Estimated cost, $25,000.

Several additions are being built to the plant of the Thomas D. Jeffrey Co., manufacturer of automobiles, Kenosha, Wis.

The contract has been awarded for the construction of a foundry building, pattern shop and vault for the Jaeschke Bros. Foundry Co., 3026 Locust St., Milwaukee, Wis. Estimated cost, $25,000.

Bids will soon be received by H. J. Stilb, 1126 Villa St., Racine, Wis., for the construction of a one-story, 50x100-ft. factory and machine shop at Racine Junction, to be occupied by the Silverkroop Engineering Co. Noted Dec. 9.

The contract has been awarded for the construction of a two-story, 70x75-ft. addition to the machine shop of the Myers Machine Co., Sheboygan, Wis.

WEST OF THE MISSISSIPPI

The Capitol Elevator Co. has awarded the contract for an addition to its plant, at Duluth, Minn. Estimated cost, $700,000.

The Great Northern Railway, St. Paul, Minn., is in the market for a long list of tools and shop equipment. F. A. Bushnell, St., Paul, Pur. Agt.

The Minnesota Manufacturing Association has started the construction of a plant in North St. Paul, Minn., for the manufacture of mechanical conveyors for domestic use and steel mills and foundries manufacturing war munitions. Estimated cost, $20,000.

John Schneider, Ellinwood, Kan., will build a new factory, at Wichita, Kan., for the manufacture of threshing machines.

F. L. Vlach and J. J. Tesar, Leigh, Neb., have awarded the contract for the construction of a garage. Estimated cost, $10,400.

The B. F. Swanson Co., manufacturer of typewriters, South 20th St., Omaha, Neb., has awarded the contract for the construction of a one-story, 30x80-ft. factory at Omaha. Estimated cost, $2,500.

Fire, Dec. 2, destroyed the garage of Barney Beard, Lander, Wyo. Loss, $30,000.

The Hannibal Wire Fabric Co., Hannibal, Mo., will build a factory at an estimated cost of $35,000.

The contract has been awarded for the construction of a garage for A. H. Jennings & Son, 1809 North Seventh St., Kansas City, Mo. Estimated cost, $20,000.

The contract has been awarded for the construction of a garage for the W. R. Nelson Estate, 17th St. and Grand Ave., Kansas City, Mo. Estimated cost, $10,000.

The Willys-Overland Co., Toledo, Ohio, will build a four-story plant at Kansas City, Mo. Estimated cost, $250,000.

The Studebaker Corporation, Detroit, Mich., is constructing a plant at Kansas City, Mo. Estimated cost, $100,000.

The Chevrolet Motor Co., Flint, Mich., plans the construction of an automobile asembling plant at Kansas City, Mo. Estimated cost, $75,000.

The Missouri Iron and Metal Co., St. Joseph, Mo., plans to issue $215,000 bonds for machinery and other improvements.

It is reported that the Studebaker Corporation, Detroit, Mich., will build a branch distributing plant at Dallas, Tex.

The City Commissioners rejected all bids for the erection of a municipal garage, at Ft. Worth, Tex.

Fire, Nov. 27 destroyed building and machine shop of M. C. Warner, 128 Nacogdoches St., San Antonio, Tex.

The Linhard Motor Co., Muskogee, Okla., contemplates the construction of a two-story, 50x118-ft. garage next spring.

The Farm Engineering Co., Sands Springs, Okla., will construct a factory for the manufacture of tractor engines.

WESTERN STATES

The Crown-Williamette Paper Co. plans to build a machine shop at Camas, Wash. Estimated cost, $75,000.

The Perfection Automatic Oiler Co., recently incorporated with $100,000 capital stock, plans to build a factory for the manufacture of a patented device at Seattle, Wash. H. P. McGuire is interested.

CANADA

The Dominion Bridge Co., Lachine, Que., is building an addition to its girder shop at Lachine Locks. Estimated cost, $22,000.

Press reports state that the Government of Canada has leased the Transcona shops near Winnipeg to a company who will equip it for the manufacture of war munitions. Sir Hubert Holt, Montreal, Que., is interested.

The International Safe and Register Co., Ft. Erie, Ont., will build an addition to its plant.

The Dominion Steel Co. is building four additions to its plant at Hamilton, Ont.

The Tallman Brass Co., Hamilton, Ont., is building an addition to its plant.

C. Richardson & Co., Wellington St., St. Marys, Ont., is in the market for machinery for the manufacture of shells.

An addition will be built to the plant of the Chapman Ball Bearing Co., Sorauren Ave., Toronto, Ont. Estimated cost, $5,000.

We have been advised that the Canadian Tygard Engine Co., Ltd., is constructing a two-story, 59x150-ft. factory at Toronto, Ont. Machinery for the manufacture of engines will be installed. Noted Nov. 25.

The Canada Forge Co., Ltd., Welland, Ont., plans to build an addition to its plant. Estimated cost, $20,000. T. J. Dillon is Mgr.

GENERAL MANUFACTURING

NEW ENGLAND STATES

We have been advised that the John C. Wilson Co., manufacturer of hats, is constructing an addition to its plant at Norwalk, Conn. Noted Nov. 25.

Plans are being prepared for the construction of a two-story, 50x130-ft. addition to the mill of Hall Bros., Norwich, Conn.

We have been advised that the Baer Bros., Stamford, Conn., is in the market for beating machinery for bronze powders. Noted Nov. 25.

MIDDLE ATLANTIC STATES

The Keuka Fiber Board Corporation, Penn Yan, N. Y., will establish a plant at Penn Yan, for the manufacture of paper and fiber board.

The Bausch & Lamb Optical Co., St. Paul St., Rochester, N. Y., has awarded the contract for the reconstruction of its glass manufacturing plant at Rochester, which was recently destroyed by fire. Estimated cost, $6,000. Noted Dec. 2.

The American Art Glass Co., Camden, N. J., has awarded the contract for a factory at 1134 South Front St.

The Clayton Chemical Co., Clayton, N. J., recently incorporated will establish a plant for the manufacture of chemical products. H. English in Mgr.

The Du Pont de Nemours Co. will build an addition to its powder manufacturing plant at Haskell, N. J.

The Davis-Bournville Co., Jersey City, N. J., manufacturer of acetylene gas apparatus, has awarded the contract for the construction of an addition to its plant on Van Wagenen Ave. Estimated cost, $70,000. Noted Dec. 9.

The Beckton Chemical Co., Newark, N. J., is having plans prepared for the construction of additions to its plant. Estimated cost, $17,000.

The Bellmark Co., Trenton, N. J., manufacturer of sanitary earthenware, will build a two-story brick addition to its plant on New York Ave.

The Anglo-American Products Co., Bristol, Penn., will establish a bleaching plant for raw cotton.

Making Pelton Waterwheel Parts

By Fred H. Colvin

SYNOPSIS—Methods used in doing large machine work are always of interest. In this case they include spherical boring, milling large steel buckets and the balancing of these buckets. Several special fixtures for holding irregular-shaped governor weights while milling and drilling may suggest other applications.

The development of the hydro-electric power plant in the mountains of the West, particularly in the use of high heads of water, is very closely connected with the Pelton waterwheel. This has been developed until it is extremely efficient, and this development has gone hand in hand with improved shop methods for its manufacture. Some of these turbines run into extremely large horsepower units, one of them reaching 20,000 hp. with a single discharge and running up to 22 ft. in diameter for the casing cover. These are used at extremely high heads, ranging in the neighborhood of 2,000 ft., and in Switzerland there are installations that are considerably higher than this.

The manufacture of the turbines includes many interesting methods, some of which are illustrated herewith.

The boring of the spherical seat for the swiveling bearing is shown in Fig. 1, the nature of the convex surface being shown at *A*. This is secured by using a substantial boring bar *B*, carrying a yoke *C*, with the cutter *D* mounted therein. The collar *E* carries a nut that fits the feed screw of this bar, and as this collar moves along the bar it swings the yoke and tool through

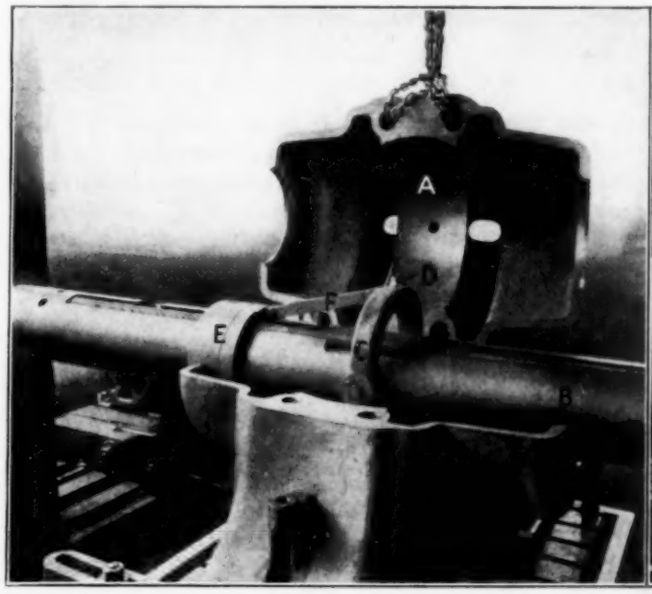


FIG. 1. BORING BALL JOINTS IN LARGE BEARING

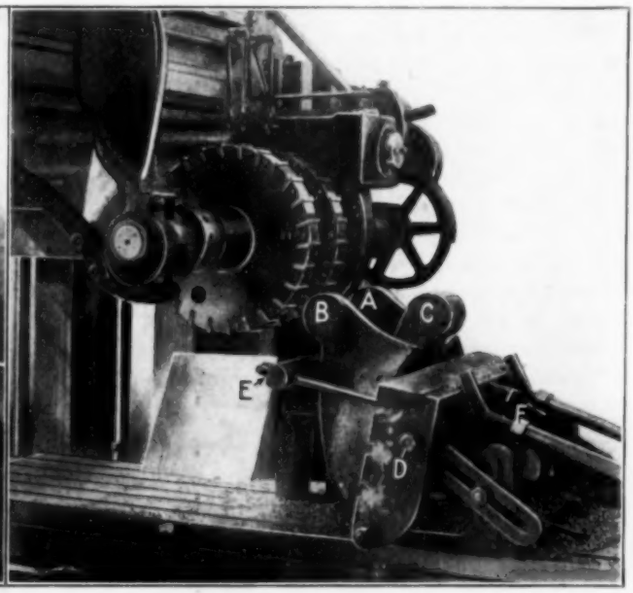


FIG. 2. MILLING BOLT PADS ON BUCKETS

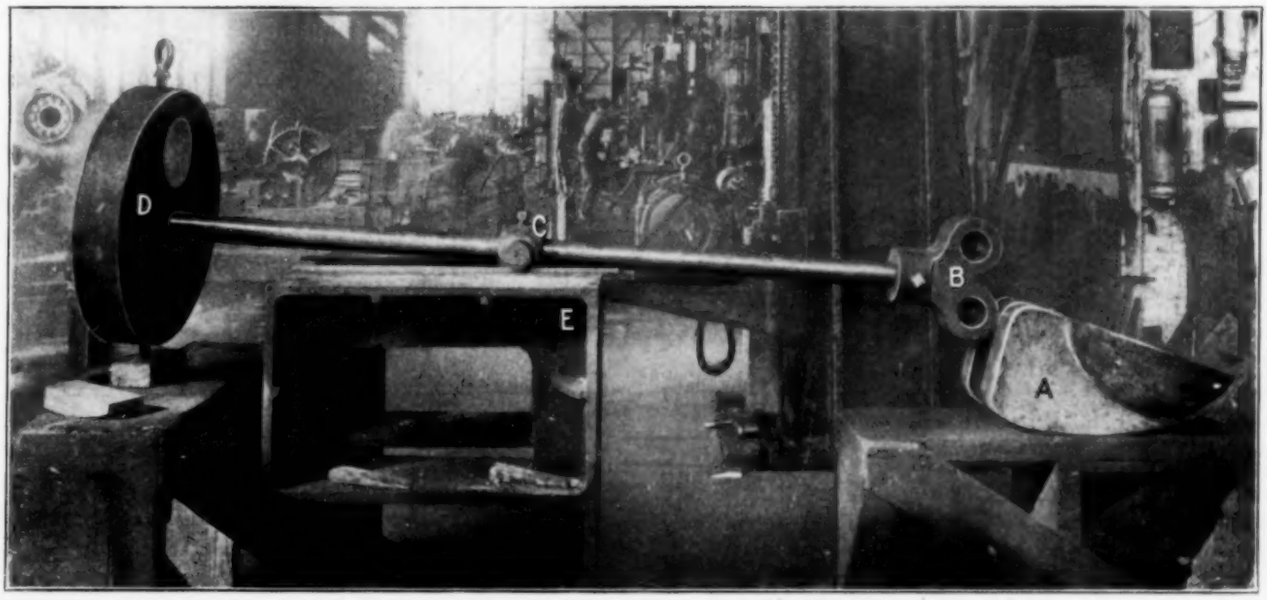


FIG. 3. BALANCING LARGE PELTON BUCKETS BY THE USE OF A SIMPLE RIG

an arc by means of the link *F*. At the same time the bar is being revolved in the usual manner. This produces the desired surface, as shown at *A*.

The buckets are made of steel castings, one being shown in position on the Beaman & Smith milling machine in Fig. 2. This is a double bucket with the three ears *A*, *B* and *C*, for attaching to the wheel, or center. The bucket is securely fastened to the adjustable angle plate *D* by the strap *E* and braced against the action of the

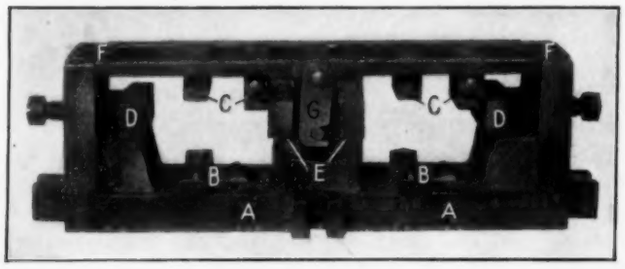


FIG. 4. LOCATING GOVERNOR WEIGHTS IN MILLING JIGS

milling cutters by the jacks *F*. These milling cutters are so spaced that the two outside faces of the cutters mill the insides of the ears *A* and *B*, while the inside faces of the cutters straddle the ear *C*, milling both sides and finishing the four surfaces at one pass of the milling cutters. These surfaces permit the buckets to be bolted to the double-rimmed wheel, such as is used on the larger sizes.

These buckets are carefully ground out on the inside surface by means of a large portable electrically driven grinder, as the efficiency of the wheel is materially increased thereby. This grinding is another evidence of the value of mass for absorbing the vibrations of machinery, as, since the introduction of a very heavy machine,

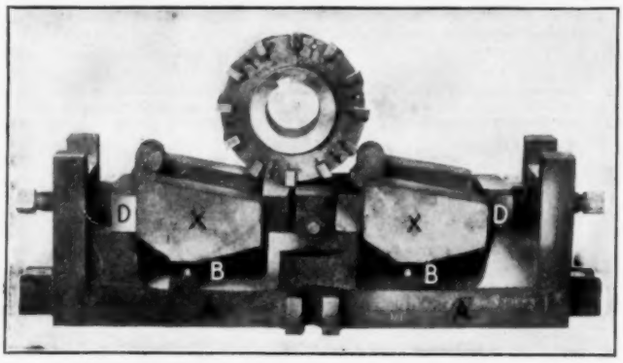


FIG. 5. HOW THE WEIGHTS ARE HELD IN THE FIXTURE

C, and the counterweight *D* shows easily whether the bucket being tested is of the correct weight or not. In the case shown the trunnion is simply balanced over a pair of uprights, one being shown at *E*. Although a very simple method, this proves entirely satisfactory and allows the weight of each bucket to be brought to agree with the others that are to be assembled on the same wheel.

One of the interesting features of waterwheel power generation is the governing, which has been developed to a very sensitive point in the Pelton-Doble governor.

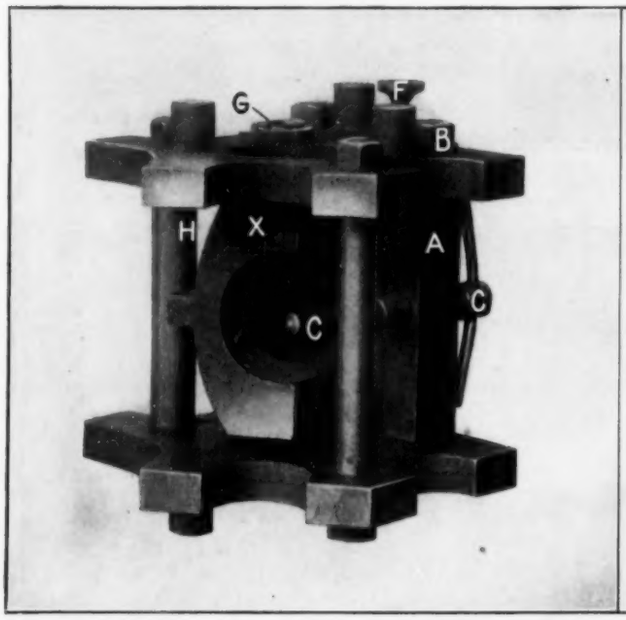


FIG. 6. DRILL JIG FOR GOVERNOR WEIGHTS

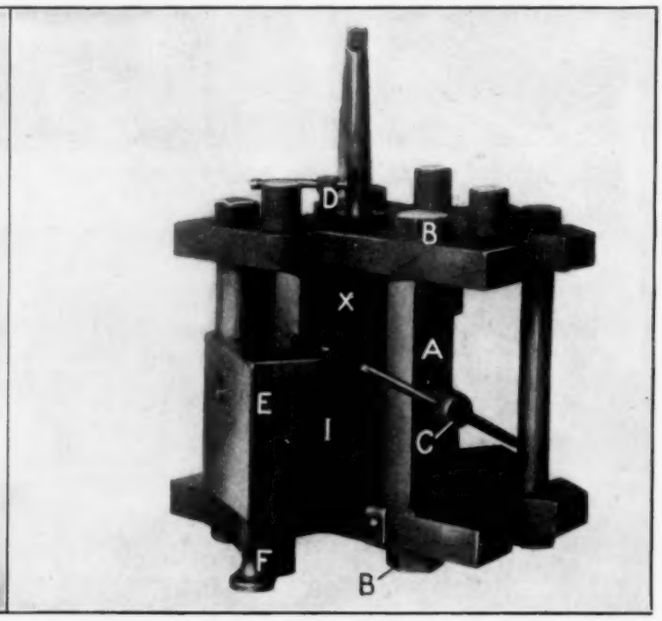


FIG. 7. THE SAME JIG PARTLY OPEN

suitably suspended from the ceiling so as to impose no more manual labor on the operator than before, a very much better grinding job is secured and in considerably less time.

The revolving member of a large Pelton waterwheel that runs at high speed must be carefully balanced if good results and safety are desired. For this purpose every bucket is balanced, or weighed, by the method shown in Fig. 3. This is a different type of bucket from that shown in Fig. 2, but the same principle is used in balancing the different sizes. In this case the bucket *A* has not been drilled to receive the attaching bolts, but when this is done it is fastened to the end *B* of the balancing beam, this representing the outer edge of the revolving wheel. This balancing bar is pivoted by the trunnion

Figs. 4 to 7 show how the governor weights are handled while being machined. The fixture *A* holds them for the milling operation, as shown in Figs. 4 and 5. These governor weights are rounded on the back and are supported in the fixture by the three points *B*, while the projections *C*, fitting in between the two sides of the

weights, center them sideways. These centering projections *C* are a part of the positioning plate *F*, which fits into the top of the milling fixture and is fastened in position by the swinging latches *G*. While held in this way, the screw clamps *D* force the governor weights *X* against the equalizing jaws *E*, and after they are securely fastened in position the positioning plate *F* is removed. This may be seen more clearly in Fig. 5, which shows a pair of governor weights after they have been milled; and also, the milling cutter used is shown poised on the center of the fixture. The reference letters correspond with those in Fig. 4.

These governor weights then go into the drilling jig shown in Figs. 6 and 7, this having several interesting points. The work *X* is held by the clamping screw *C*, which is mounted in the swinging support *A*, this being held in position by the capscrews *B*. The governor weight is slipped into the drilling jig, as shown in Fig. 6, and the clamping screw *C* is swung so as to bear against the inner part of the curved surface and hold it securely in place against two uprights, one being shown at *H*. Fig. 7 gives another view of the jig, showing the weight locked in position and the arm *E* also swung so as to bring the drilling bushing over the ear *I*, this swinging arm being locked by the plunger *F*. The small jackscrew *D* also helps hold the weight in position. As can be seen from the feet on the different sides of this drilling fixture, it provides for holes drilled at varying angles and altogether makes a very compact and interesting drilling jig.

The Evolution of a Design

By Rudolph L. Hanau

The evolution in the design and manufacture of a mechanism, device or part is mainly governed by: (a) Improvement in operation; (b) number required; (c) time set for the work; (d) manufacturing facilities; (e) safety and convenience in operation; (f) expense

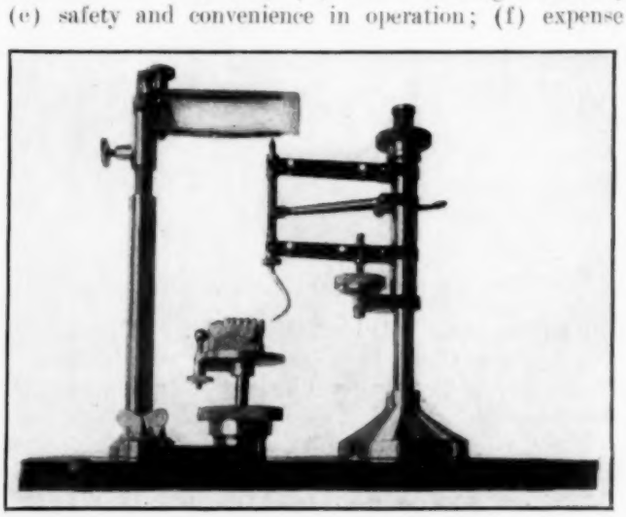


FIG. 1. MODEL AS FIRST MADE

for labor and material. One or more or all of these main factors may have to be considered.

The experienced engineer will readily recognize the complicated interrelation of these factors and their influence upon the resultant product. Even to try to formulate general rules for handling work and material in the design and manufacture of machinery, particularly in its primary stages, would be a rather foolish undertaking. In this article will be described the sequence of changes found desirable when manufacturing a dental surveying apparatus.

In making the assembly drawing, no dimensions were allowed to be scaled and only those indicated on the detail drawings were used.

In Fig. 1 is shown the apparatus evolved from the first model. It incorporates improvements that suggested themselves while building and operating the first model. Although this improved model gave perfect results, it was nevertheless found that small improvements could still be added, especially to facilitate manufacture. Before making a new and larger lot it was decided to redesign the entire machine for the following reasons: (1) To incorporate further improvements facilitating manufacture; (2) to improve its appearance; (3) to avoid constructions which might possibly lead to repair work. The parts had to be designed in such a manner that any first-class small shop would be able to turn out the work in reasonable time at reasonable cost. It must be borne in mind that the entire demand for such apparatus may not exceed 200.

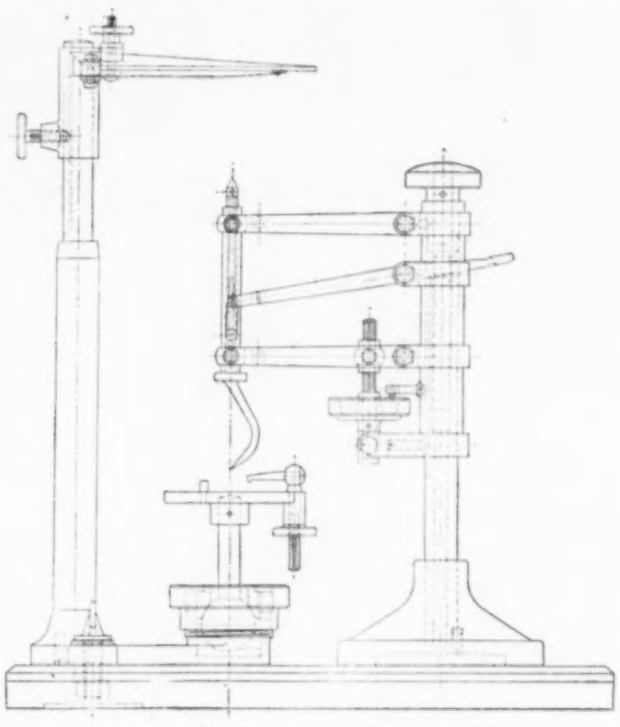


FIG. 2. DESIGN OF LATEST MODEL

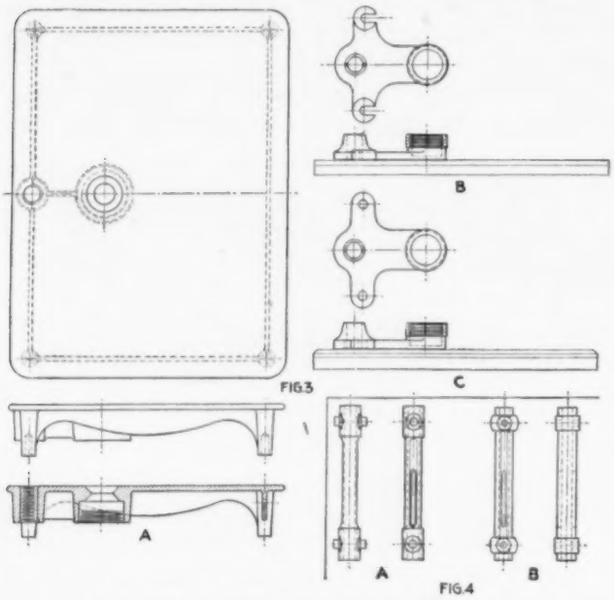
Attention had to be paid to neat appearance, inasmuch as the dental surveying apparatus in the orthodontist's office is a counterpart of the surgeon's microscope.

The elimination of repair work as far as could be foreseen was an important factor on account of the expected widely scattered users. Therefore all parts were safely built and all movements made positive.

In Fig. 2 is shown the design of the latest apparatus. In Fig. 3 the changes that the base plate has undergone are illustrated. At *A*, a casting composed of one part served as a surveying plane, as a support for the paper holder and as a socket for the ball end of the vise table. At *B* a separate casting served for the socket and an independent surveying base (a glass plate on a mahog-

any board) has been provided for. *C* shows the casting in a more simplified form.

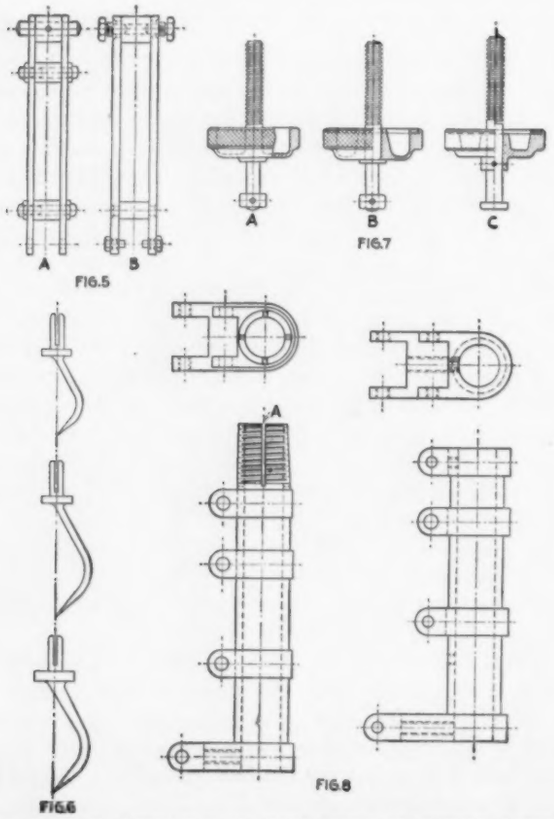
Fig. 4 shows the sleeve that carries the sliding shaft and extension. This sleeve has been reduced from three



FIGS. 3 AND 4. CHANGES IN DETAIL PARTS

parts to one, and the pivot ends substituted by bored holes into which pivot, end studs extend. The arm, Fig. 5, which originally was made up of nine parts *A* and rather difficult to assemble, now consists of four parts *B* rigidly connected by riveting and easily handled as a unit when assembling.

The extension, Fig. 6, has been lengthened to have a further reach and has been provided with a ball end



FIGS. 5 TO 8. DETAILS IN IMPROVED MACHINE DESIGN

to reduce the strain on the eye while surveying. Finally, the metal has been dulled for this same reason and the part strengthened to make it more rigid.

Fig. 7 shows the graduated wheel on a threaded spindle. The wheel has the graduation and numerals engraved on the side surface of the rim, facing upward. *B* shows this device made up of three different parts. While *A* was originally cut out of one solid piece of steel, in *B* the spindle only is made of steel and the wheel of composition metal that is noncorrosive and therefore not attacked through handling. A separate white celluloid ring, showing the graduations and numerals in black, has been inserted to facilitate more accurate reading. The wheel rests on a shoulder and is driven into position. In *C* the wheel is pinned to the spindle, the shoulder omitted and a head at the lower end provided for thus substituting a collar.

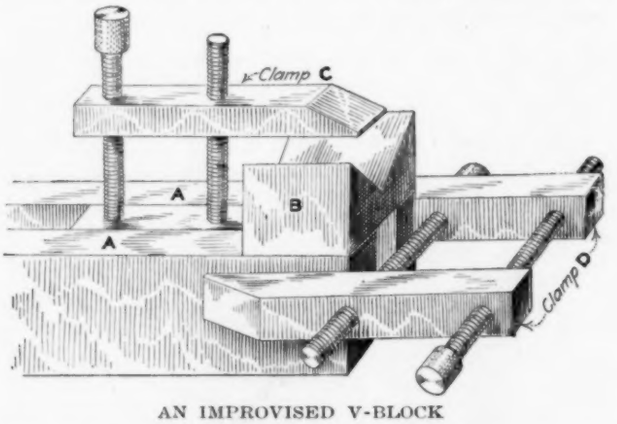
The sleeve bracket, Fig. 8, has been reduced and simplified in its elements. The upper slit and taper-threaded end which served to clamp the sleeve into position on the upright *A* have been left out and a different and more positive construction for vertical adjustability decided upon.

An Improvised V-Clamp Block

By H. B. Schell

Having occasion recently to use a V-block with a clamp and not having one available, I employed the device shown in the sketch. It consists of a pair of parallels *A*, a small V-block *B* and a pair of parallel clamps *C* and *D*.

The work was clamped in the V with clamp *C* and placed on the parallels as shown. Clamp *D* is used to

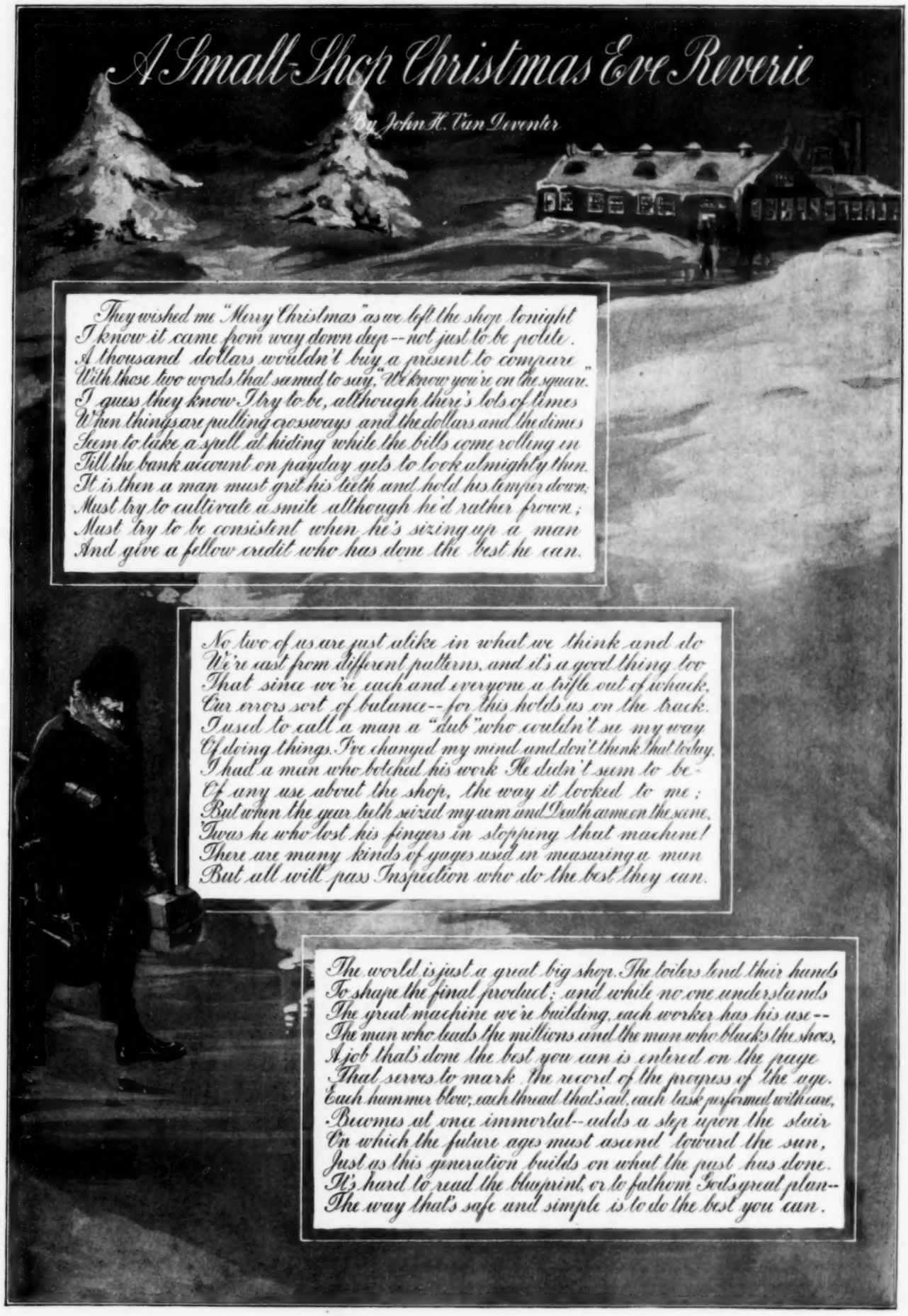


AN IMPROVISED V-BLOCK

hold all the parts together. By slacking off the back screw on clamp *C*, the pieces may be changed; by adjusting both screws, pieces of different diameters can be accommodated.

Care should be exercised to have the bottom of the V-block rest squarely on the parallels.

Test of Government Bronze—The quality of metal castings is usually determined by measuring the properties of a test specimen cast from the same metal. The United States Bureau of Standards has completed an investigation of the various foundry operations that influence the properties of the test specimen, for one of the most generally used commercial alloys, known as Government bronze, having the composition 88 copper, 10 tin and 2 zinc. The bureau studied the effects of temperature on casting, methods of gating, casting, molding, kind of sand, heat treatment and the effect of similar factors on the resulting mechanical properties.


A Small-Shop Christmas Eve Reverie
By John H. Van Deventer
They wished me "Merry Christmas" as we left the shop tonight
I know it came from way down deep -- not just to be polite.
A thousand dollars wouldn't buy a present to compare
With those two words that seemed to say, "We know you're on the square."
I guess they know I try to be, although there's lots of times
When things are pulling crossways and the dollars and the dimes
Seem to take a spell at hiding while the bills come rolling in
Till the bank account on payday gets to look almighty thin.
It is then a man must grit his teeth and hold his temper down,
Must try to cultivate a smile although he'd rather frown;
Must try to be consistent when he's sizing up a man
And give a fellow credit who has done the best he can.
No two of us are just alike in what we think and do
We're cast from different patterns, and it's a good thing too
That since we're each and everyone a trifle out of whack,
Our errors sort of balance -- for this holds us on the track.
I used to call a man a "dub" who couldn't see my way
Of doing things. I've changed my mind and don't think that today.
I had a man who botched his work. He didn't seem to be
Of any use about the shop, the way it looked to me;
But when the year's toll seized my arm and Death was on the scene,
'Twas he who lost his fingers in stopping that machine!
There are many kinds of gages used in measuring a man
But all will pass Inspection who do the best they can.
The world is just a great big shop. The toilers lend their hands
To shape the final product; and while no one understands
The great machine we're building, each worker has his use --
The man who loads the millions and the man who blacks the shoes.
A job that's done the best you can is entered on the page
That serves to mark the record of the progress of the age.
Each hammer blow, each thread that's sail, each task performed with care,
Becomes at once immortal -- adds a step upon the stair
On which the future ages must ascend toward the sun,
Just as this generation builds on what the past has done.
It's hard to read the blueprint, or to fathom God's great plan --
The way that's safe and simple is to do the best you can.

A Sharp Deal and What It Cost

By John R. Godfrey

I ran across an aggravated case of the "so-much-a-pound" buyer the other day. Of course weight, generally speaking, has a bearing on the price of most any commodity, but there's a heap of difference in the cost per pound whether you are buying cast iron and steel in the rough or made up into a precision lathe. And it's even more of a problem when it's a special machine built for a particular job.

That's what makes this such a horrible example. Mr. Customer wanted a machine built for a special job, and Mr. Builder agreed to make one for a certain price, which was satisfactory to both parties. But Mr. Customer was a bug for weights and wanted to know what the machine would probably weigh. Mr. Builder thought it over a bit, and to play safe, guessed about a thousand pounds and thought no more about it.

In the fullness of time, however, the machine was finished and delivered and was pronounced satisfactory as to output. Mr. Builder's mind, strangely enough, lightly turned to thoughts of payment. And here he met with rude and grievous disappointment. For the letter from Mr. Customer read about thusly:

"The machine is running and doing all that you claimed. You will remember, however, that the estimated weight was 1,000 lb. We find it weighs but 850 lb. As you estimated on 1,000 lb. in fixing the price and you saved 15 per cent. for material, the cost to you was correspondingly lessened thereby. We accordingly inclose check for 85 per cent. of the contract price, which we trust will be satisfactory to you"—etc.

Where the Weight Basis Hurt

Was this satisfactory? It was not, any more than it would have been to you or me. And when Mr. Builder came back to terra cotta sufficiently to dictate a letter without scorching the ear drums of the queen of the pothooks and the keyboard, he pointed out several things in choice and artistic language. Among them were that 150 lb. of metal in no wise represented 15 per cent. of the price; that the machine was not sold by weight and that the weight was incidental; that he contracted to build a machine to perform certain work, and as long as he did that he might make it of any weight he chose.

But Mr. Customer had the courage of his convictions, also the checkbook, and although Mr. Builder might have won out in a lawsuit, he dropped the case and pocketed his wrath along with the 85 per cent. The machine was of no value to anyone else, and he tried to forget about the things he might have bought with that 15 per cent.

Time fullnessed a few more and played into Mr. Builder's hands much sooner than he dreamed. The machine worked so well and produced so cheaply that Mr. Customer wanted another machine. So he innocently came back for No. 2, probably expecting Mr. Builder to jump at the chance to build one.

But he didn't jump—not so you'd notice; that is, not at the order. He jumped on Mr. Customer with both feet, however. Reminded him of the 15 per cent. rebate and the low-down cussedness of the man who would even try to put over a game of that kind. Told him to go plumb to —— and to keep going; that he wouldn't build him a machine at any price; that he'd prevent anyone else building it because some of his patents were necessary to its success; that he hoped Mr. Customer would lose a lot more than he had on the machine and learn to buy machines like a white man in future.

Then he felt better—as most of us would. But while it's a heap of satisfaction to get even in a case of this kind, when you stop to figure it out a bit it's a good deal like the average war—everybody loses in the long run. There sure ought to be some better way out of it.

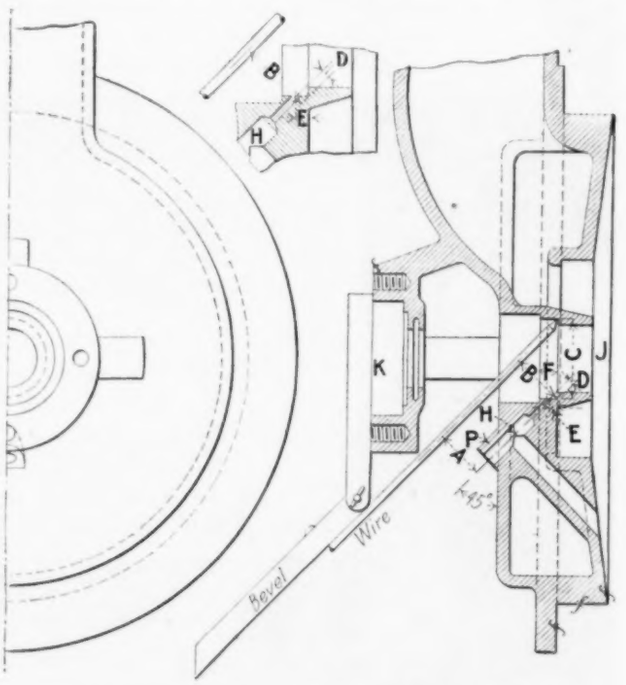
Interesting Angular Layout

By Ernest Price

The accompanying illustration shows a centrifugal pump-head casting in which the hole *H* had to be laid out and drilled so as to come in the center of the recess *F*, this being absolutely necessary on account of the principle involved in the balancing of the pump thrust.

The layout might seem perplexing to a machinist used to "cut-and-try" methods, especially as one could not be sure that the centering of the projection *P* would center the hole in the recess *F* as required.

By examining the sectional view again you will see that the layout was not difficult. The dimensions of



Making an Angular Drilling Layout

C and *F* are known and the hole is to be drilled at an angle of 45 deg. The piece was strapped to an angle-block set at 45 deg., and I then took a short straight piece of drill rod sharpened true to a point and squared up from the face *K* with a bevel gage, carefully laying out the distance *A* minus the radius of the rod with a short scale.

The distance *A* was determined by the following trigonometrical relations:

$$\textit{Sine } 45 \textit{ deg.} \times C = B; \textit{ sine } 45 \textit{ deg.} \times F = D;$$

$$B - D = A$$

The results were satisfactory, especially as the time for making a jig could not be spared.

Jigs for Making Fire-Engine Motor Details

By Robert Mawson

SYNOPSIS—For milling the oil scoop and sawing the connecting-rods a novel fixture is used. It is made with locating arbors placed in such positions that the surfaces to be machined will be horizontal. After the scoop has been machined the rods are placed on other locating arbors in the same fixture and the rods split. A multiple milling fixture for use on the bearing caps is designed to enable the faces and register being machined at one setting. The fixture employed for milling the valve lifter guides is also of the continuous machining type and is fitted with quick-acting fastening latches operated by one motion.

Some of the tools used by the Seagrave Co., Columbus, Ohio, in manufacturing fire-engine motors have been shown in previous articles. In this article are illustrated and described other tools employed by this company. One of the finish-machined and assembled connecting-rods is shown in Fig. 1.

The jig used in boring the crankshaft and wrist-pin holes in the rod is illustrated in Figs. 2 and 2-A. The forging is located by adjustable setscrews on the sides and the end *A*. The hole for the crankshaft bearing *B* is then rough-bored and reamed to 3⅛ in. The wrist-pin end *C* is drilled and reamed to 1¾ in., slip bushings being provided to guide the tools.

The fixture used for milling the oil scoop and sawing the connecting-rods is shown in Figs. 3 and 3-A. It is designed to hold two sets of three rods. These are placed first on the arbors *A* and *B*, which are made the same size as the machined holes in the rods. The upper surface of the oil scoop is then milled. As one set of rods is being machined another set may be placed in position by the operator, thus making the machining operation as nearly continuous as possible.

After the oil scoop has been machined the rods are located by the machined arbors *B* and *C* and placed in the position shown. A set-up of cutters consisting of two 4 in. by ½-in. wide side mills and a 6 in. by ⅛-in. thick saw, accurately spaced, is then used to machine the sides

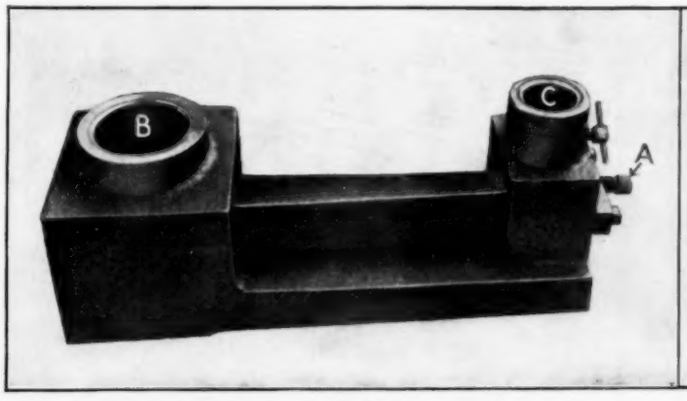


FIG. 2. LARGE BORING JIG FOR ROD

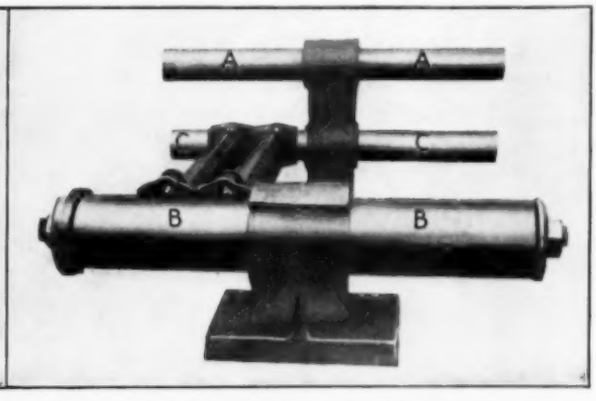


FIG. 3. SAWING FIXTURE FOR RODS

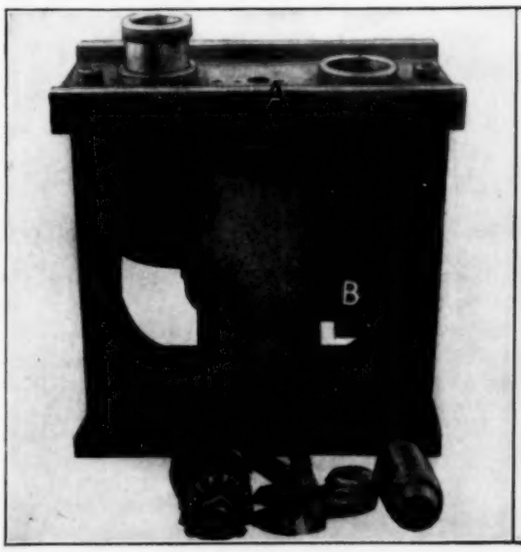


FIG. 4. DRILL JIG FOR CYLINDER

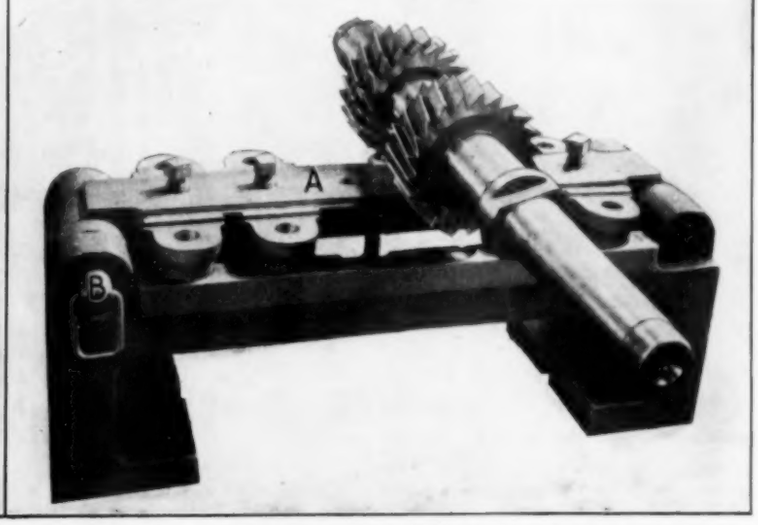
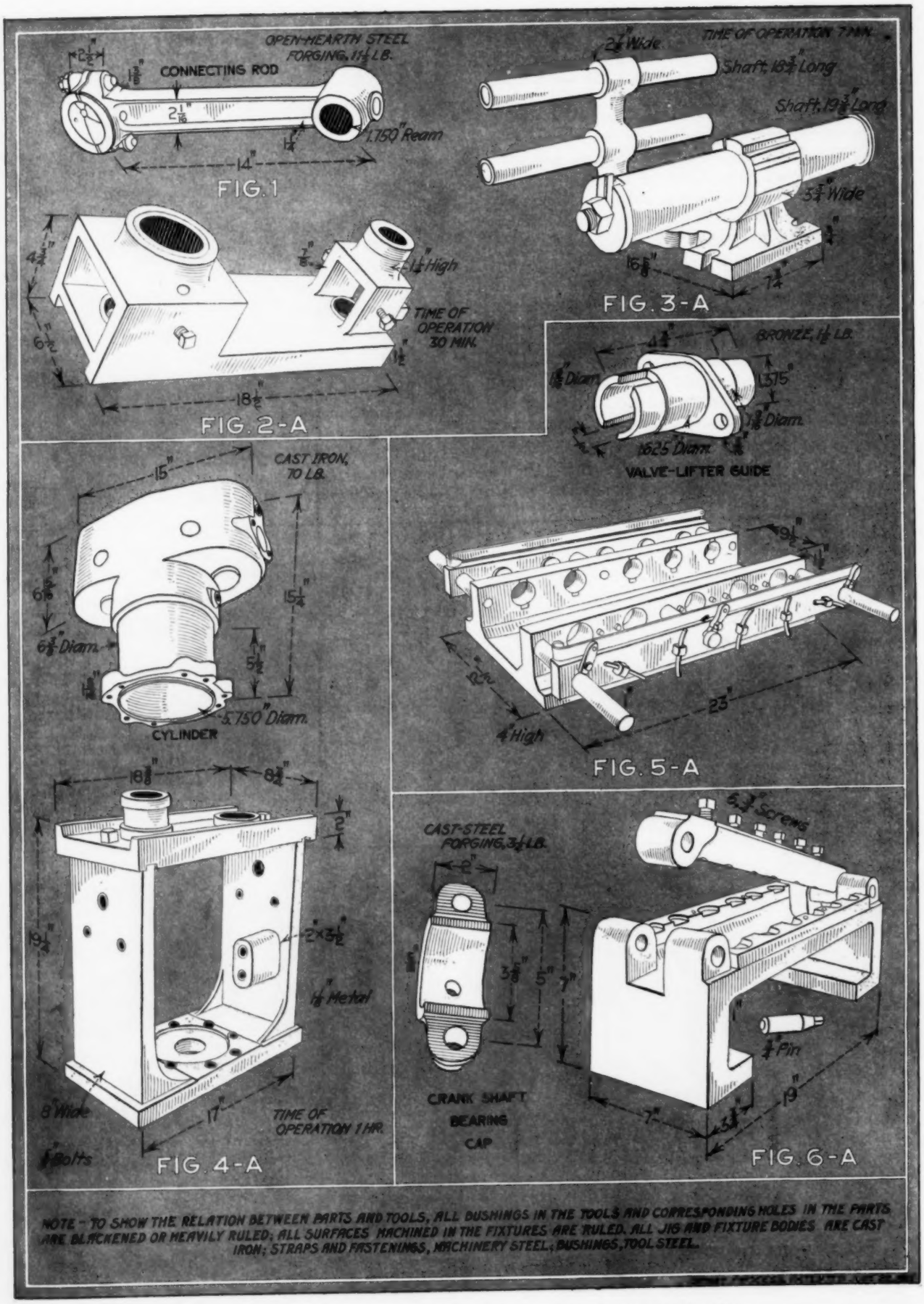


FIG. 6. MILLING CRANK-BEARING CAPS



DETAILS OF JIGS USED IN MACHINING FIRE-ENGINE MOTOR DETAILS

of the bolt bosses and also part of the cap from the rod. The cutters operate at 32 r.p.m. with a feed of 0.033 in. per revolution. The procedure is such that the operation is practically continuous. The fixture is located by tongues and held to the machine table with bolts in the usual manner.

The jig used for drilling the cylinder is shown in Figs. 4 and 4-A. The cover *A* is first removed and the cylinder dropped into the jig. The casting is located by a circular-machine recess and a finished pad *B*. These details may be better observed by referring to Fig. 5-A. The cover is then placed in position and located by dowels in the jig body and held by the two bolts shown. The following holes are then machined: Four $^{33}/_{64}$-in. drill in the base flange, two $\frac{5}{16}$-in. drill for the water-inlet flange,

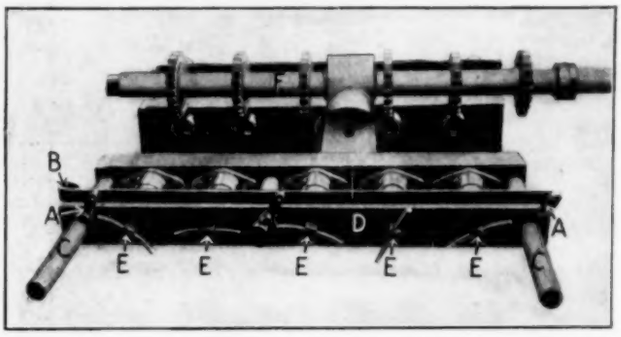


FIG. 5. MILLING VALVE-LIFTER GUIDES

four $\frac{3}{8}$-in. drill and one $\frac{3}{4}$-in. drill for the inlet and exhaust flanges. The $\frac{5}{16}$-in. holes are later tapped with $\frac{3}{8}$-in. 16 U. S. S. threads, the $\frac{3}{8}$-in. holes tapped with $\frac{7}{16}$-in. 14 U. S. S. threads and the $\frac{3}{4}$-in. hole tapped with $\frac{7}{8}$-in. 18 U. S. S. thread.

For the valve guides the following holes are also machined in this jig: Two $\frac{7}{8}$-in. drill and ream, two $2\frac{7}{8}$-in. bore and ream, two holes 45 deg. countersink, two holes bore and tap with 3-in. 14 U. S. S. form thread and two holes 3.002 in. counterbored $\frac{7}{8}$ in. deep.

The tools used for these various operations on the valve holes are shown in front of the jig. All the tools in the jig are guided through bushings, to insure correct alignment of the holes.

The fixture employed in milling the slots in the valve-lifter guides is shown in Figs. 5 and 5-A. The tool is designed to hold two sets of five pieces, one of these being loaded while the other is being machined. The guides are located by pins that fit into the drilled hole in the flange.

The body of the guide fits into a machined hole in the fixture as shown. After a set of five parts has been placed in position the hooks *A* are swung over with the hooked rod *B* and connected to it. These hooks engage notches in the bars *C*. The plate *D* is thus held firmly on the guide bars *C*. The pin-headed screws *E* are then tightened. The inner end of these screws forces a flange, which bears against the end of the guides and pushes back and holds the parts securely in the fixture. The gang of cutters *F*, which are 4 in. by $\frac{1}{2}$ in. wide, is then fed against the guides, thus machining the slots required.

The cutters operate at 200 r.p.m. with a feed of 0.06 in. per revolution. The fixture is located by tongues and held to the machine table with clamps or bolts in the usual manner.

The fixture used in milling the face and recess in the crankshaft bearing caps is shown in Figs. 6 and 6-A. It holds six parts. These are placed in recesses as shown and located by the cover clamp *A*, which is made with a circular contour and sets into the caps. The pin *B* is slid into place and holds the clamp in position. The setscrews in the clamp, one for each cap, are then tightened to the parts to hold them securely. The cutter set-up comprises two 4x$2\frac{3}{4}$-in. and two $3\frac{3}{4}$x$\frac{1}{2}$-in. cutters. These operate at 120 r.p.m. with a feed of 0.03 in. per revolution and machine the faces and form the register as shown.

Some of the Shops in Brazil and Uruguay

The accompanying illustrations from among the shops visited by the *American Machinist* representative, Duncan N. Hood, while in Brazil and Uruguay have much of general interest. The exteriors are so different in appearance from shops in the United States that this paper feels justified in illustrating a few of them, even though it is contrary to its usual policy. The interiors naturally bear a fairly close resemblance to our own shops, although several interesting details will be found in the different views.

The first three illustrations (Fig. 1, 2 and 3) show the exterior and interior of the shop of Martins & Barros, of Sao Paulo, Brazil. Fig. 2 gives a good idea of their fairly large foundry, with the two cupolas at the farther end. The molding floor is served by a traveling crane. Only the tension rods and a portion of the truss framing can be seen in the illustration. A low partition divides this from a part of the machine shop, as can be seen on the extreme right. This view also shows the I-beam construction used in the overhead framing for supporting the counter and line shafting for driving the machine tools. The columns are of steel and the corrugated-iron siding shown behind the cupolas indicates that extension in this direction has been provided for.

A view of the machine shop itself is shown in Fig. 3, the most prominent feature being a large arbor press of the Greenerd pattern. This illustration also shows many details of the steel supporting columns and the overhead work and gives some idea of the class of machine used in the shop.

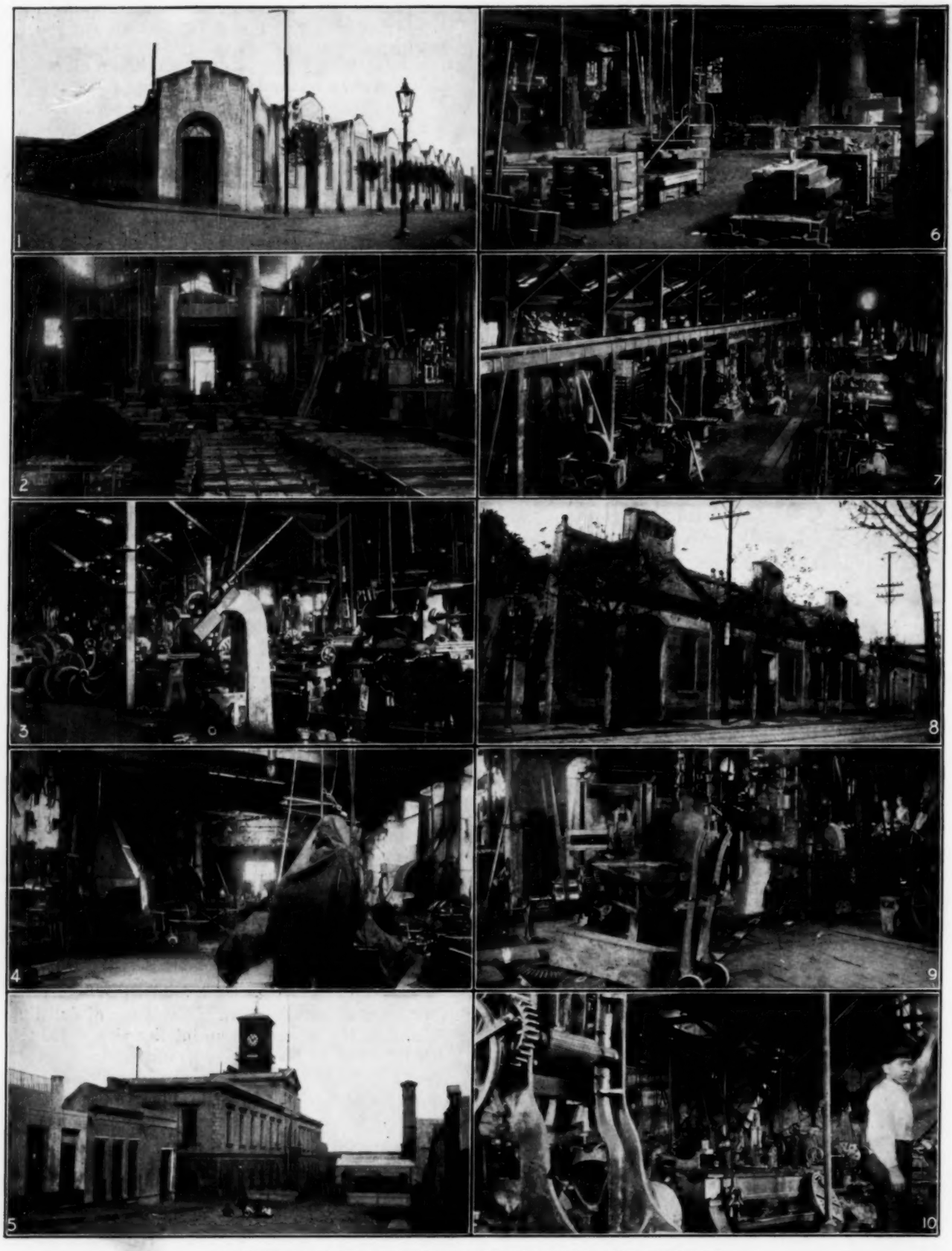
Idle Machines Protected from Dirt

Mute, but nevertheless striking, evidence of dull times is shown in Fig. 4, which is an interior view of the shop of J. Gaggioni, of Montevideo, Uruguay.

The two machines in the foreground, which have the appearance of vertical grinders or drilling machines, are covered with tarpaulins to keep out dirt and to protect them from rust during the period of inactivity. The two forges, one at each side of the shop, as well as the gap punch at the extreme left, indicate that considerable blacksmithing, or perhaps plate work, has been done here.

The building shown in Fig. 5 is not a court house, but the exterior of the Mana Dry Dock Co., of Montevideo, Uruguay. It is a substantial-appearing building. The workshop is beyond and to the right. No interior views could be obtained.

The Lidgerwood Manufacturing Co. has established a fair-sized plant at Sao Paulo, Brazil, as shown in Figs. 6



FOUNDRIES AND MACHINE SHOPS IN BRAZIL AND URUGUAY

Fig. 1—Exterior of Martins & Barros, Sao Paulo, Brazil. Fig. 2—A view in the foundry. Fig. 3—The machine shop. Fig. 4—Shop of J. Gaggioni, Montevideo, Uruguay. Fig. 5—The Mana Dry Dock Co., Montevideo, Uruguay. Fig. 6—Lidgerwood Manufacturing Co.'s foundry, Sao Paulo, Brazil. Fig. 7—The Lidgerwood machine shop. Fig. 8—Shop of George Craig, Sao Paulo, Brazil. Fig. 9—Some of the machines used. Fig. 10—Shop of J. A. Martins, Sao Paulo, Brazil

and 7. Fig. 6 is a view of a remarkably clean foundry, in which are cast a large number of bells for churches and other purposes. This forms quite an appreciable percentage of the company's business, which has established a reputation for its product. Fig. 7 is a view in the main bay of the machine shop. In common with the majority of shops in this section, it has a dirt floor. Only the very largest shops have cement or wooden floors. As shown in the photograph, the equipment is varied, and it is interesting to observe that a number of fence-like guards have been erected around belts and the more dangerous machinery. The traveling crane serves this bay, while a small shop railway gives additional service down the center aisle.

A somewhat different type of building is shown in Fig. 8—the shop of George Craig, also of Sao Paulo, Brazil. Fig. 9 is a view of a portion of the interior of the Craig shop and gives a good idea of the general equipment. The shop seems to be particularly well supplied with drilling machines, although these are probably grouped and do not predominate to the extent indicated in the particular view shown.

There is also in Sao Paulo, Brazil, a shop belonging to J. A. Martins, an interior view of which is shown in Fig. 10. The method of supporting the countershafts is somewhat unusual, while the lathe in the foreground seems to have been designed and equipped for special purposes.

Tools for Producing a Jackshaft

EDITORIAL CORRESPONDENCE

SYNOPSIS—In this article are illustrated some of the tools used in manufacturing a jackshaft so that the various sets of holes on the details will be in the correct relative position. In most cases simple means are used, but these are none the less effective. In drilling a set of holes the position for the jig is obtained by a slot against some fixed surface. On the second jig an arm through which an index pin is placed enters one of the holes already machined, thus bringing the two sets of holes in the desired location.

The American Die and Tool Co., Reading, Penn., manufactures various types of automobile transmissions. In Fig. 1 is shown one of the jackshafts recently made by that company. It will be noticed that the construction of this drive is of a rigid nature. Some of the more interesting tools used when making this jackshaft are shown herewith.

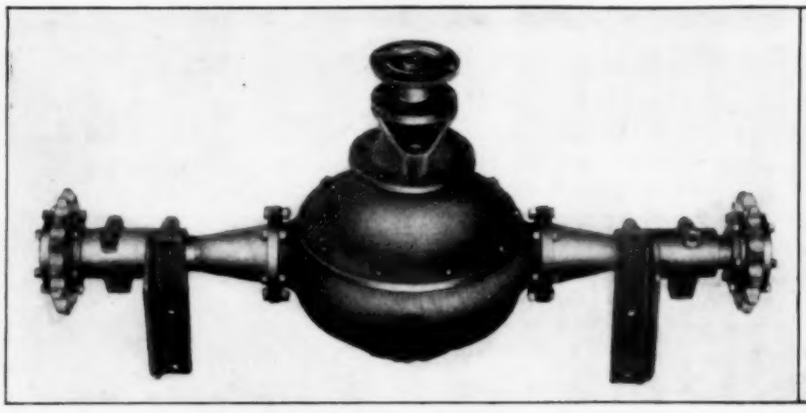


FIG. 1. ASSEMBLED JACKSHAFT OF RIGID CONSTRUCTION

FIG. 2. DRILL JIG FOR RETAINER

In Fig. 2 is shown the jig used for drilling the differential bracket-bearing retainer. This casting has been previously bored, faced and turned. The jig is made with a register which fits into the turned recess of the casting at *A*. The location for the jig is obtained by the pin *B*, the tool being slid around in the register until the pin bears against the casting as shown. A ¾-in. hole is then drilled and reamed at *C* and four 25/64-in. holes are drilled at *D*. The jig is then removed and the latter holes are tapped with ⅜-in. 20 threads.

When drilling the holes in the retainer flange the jig shown in Fig. 3 is used. The pin *A* is placed in the ¾-in. hole reamed in the previous operation. The jig plate *B* is then dropped over the casting, which fits over a turned register. The plate is placed in such a position that the plate *C* fits into notches of the pin and jig plate as shown. The jig is then in the correct relative position with the holes already machined.

Six 33/64-in. holes are then drilled in the flange, the tools being guided through the bushings shown.

The jig used in drilling the axle housing is shown in Fig. 4. The casting has been previously bored, flange-faced and turned. The jig plate is then placed on the casting, a turned register fitting into the large bore. The plate is swung back until the stop *A* comes in contact with the flange as shown. The jig is then in the correct relative position and ten 21/64-in. holes are drilled in the flange through the bushings. The jig is afterward removed and the holes are tapped with $\frac{5}{16}$-in. 22 threads in the regular way.

For drilling the holes on the flanges of the axle housing the jig shown in Fig. 5 is used. The jig is made with a recess which fits over the turned flange. The tool is then slid around until the plate *A* is in such a position that the index pin *B* will enter the hole machined in the previous operation.

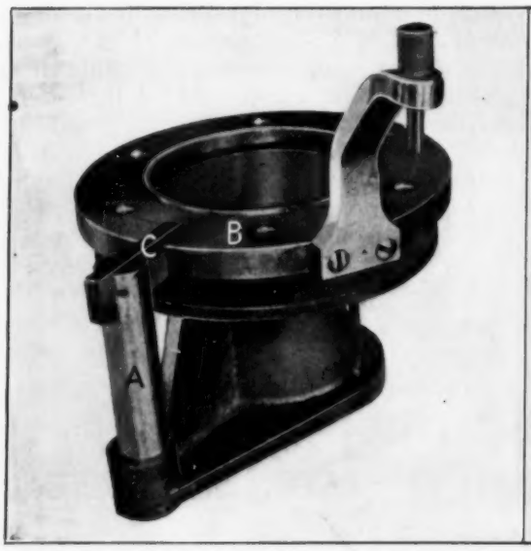


FIG. 3. DRILL JIG FOR RETAINER FLANGE

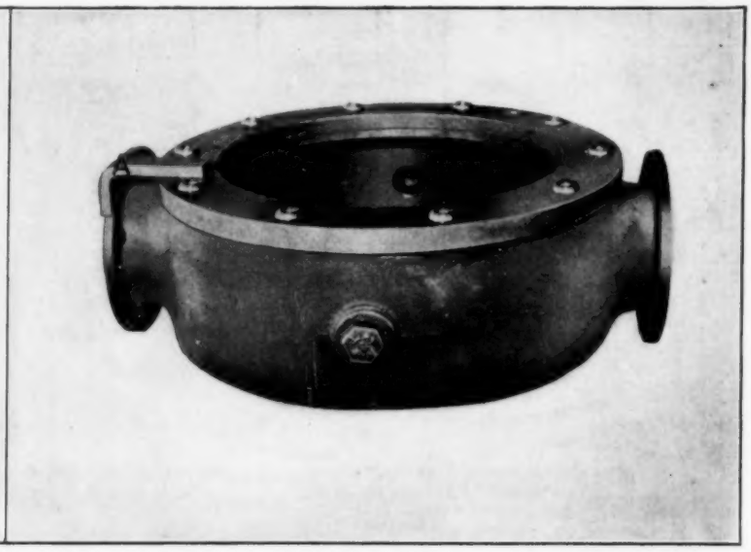


FIG. 4. DRILL JIG FOR AXLE HOUSING

FIG. 5. DRILL JIG FOR HOUSING FLANGE

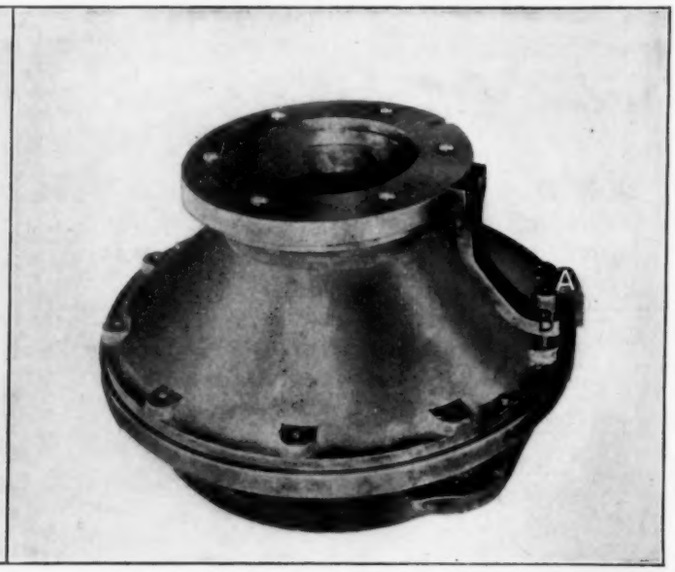


FIG. 6. DRILL JIG FOR BEARING RETAINER

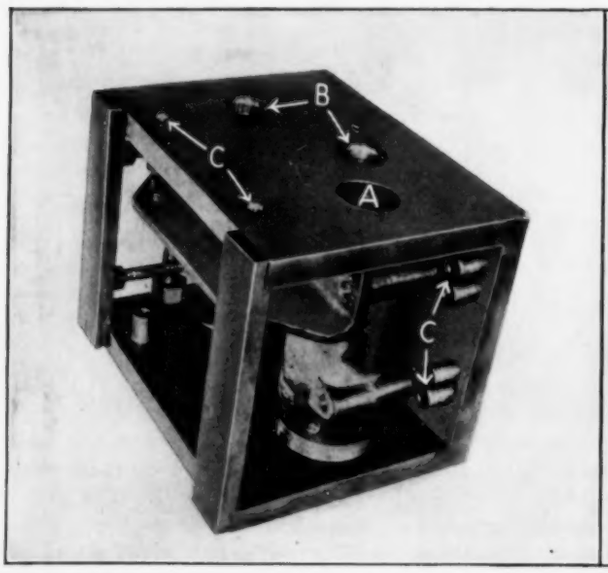


FIG. 7. DRILL JIG FOR BRACKET

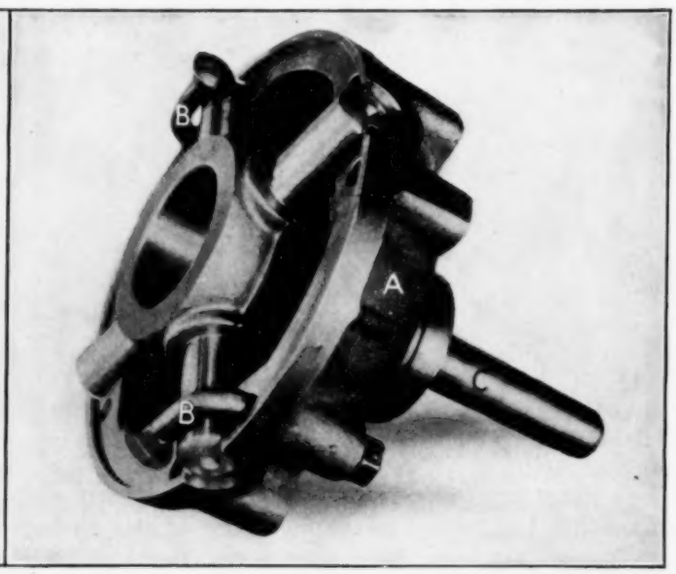


FIG. 8. FIXTURE FOR GRINDING CROSS

Six 33/64-in. holes are then drilled in the flange. Holes in the outer flange are machined in a similar manner, using the same jig and method of locating. The jig used in drilling the axle housing-bearing retainer is shown in Fig. 6. The casting has been faced and bored in a previous operation.

The jig employed for drilling the holes on the under surface is located by the slot *A*, which is brought against one of the bosses as shown. The jig for the flange is then placed in position and slid around in its register until the register pin *B* fits into one of the holes drilled in the previous jig. Six 33/64-in. holes are then drilled in the flange. By this method of location both sets of holes will be in the correct relative position.

When drilling the axle-hanger brackets the jig shown in Fig. 7 is used. The casting is located by a 2½-in. arbor *A*, which fits into a hole previously machined. The various screws shown are then tightened against the part to hold it rigid. Two 1¼-in. holes are then drilled and reamed through the bushings *B* and six ½-in. holes are drilled through the bushings *C*.

The fixture used in grinding the hole in the spider cross is shown in Fig. 8. The turned part is placed in the fixture *A*, which has been made from a differential housing. The hook bolts *B* are then swung over and tightened to hold the part in position. The arbor *C* fits in the grinding machine, and as the spider cross is revolved, the hole will be ground central with the arms, being held in a position similar to that it will occupy when fitted to the transmission mechanism.

Molding a Bakelite Bobbin

By G. Poncet

Bakelite is a synthetic compound of carbolic acid and formaldehyde. It can be obtained in any color, but when molded in black, like hard rubber, it is harder and can be molded much quicker.

Slots, threaded holes, etc., can be molded in Bakelite. Metal inserts can easily be molded in Bakelite, and it

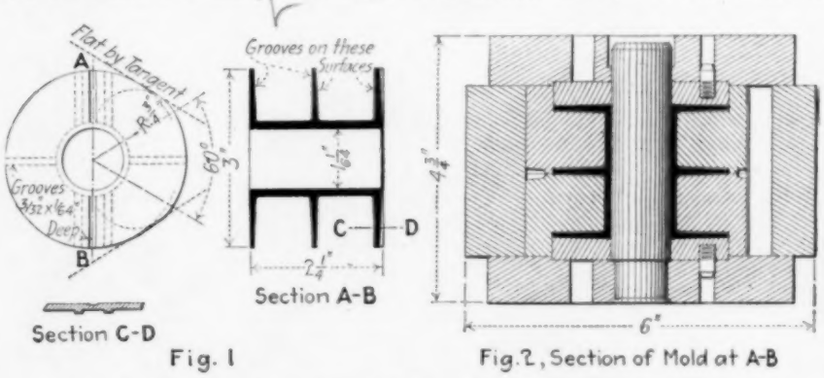


Fig. 1 Fig. 2, Section of Mold at A-B

FIGS. 1 AND 2. A BAKELITE BOBBIN AND THE MOLD

can be milled, drilled, tapped and polished. It resists much higher heats than hard rubber and will not become dull or turn color when exposed to weather.

Bakelite requires from 1 to 5 min. to mold hot under great pressure. Cooling also takes place while the work is under pressure and requires about a minute in a press which is cooled by running water. To accomplish the best results extreme care is necessary.

After many experiments molds made of Ketos oil-hardening steel, hardened in light fish oil and polished to a glass finish, have been found suitable. This is very important to prevent sticking in the mold, which may spoil sharp corners.

It is also important to use nonshrinking steel, as many molds have parts that cannot be ground after hardening. The main object in using good steel is the pressure under which it is used, often from 75 to 100 tons' pressure being required to press the material.

In molding Bakelite two types of molds are used—the subcavity and the overflow mold. The subcavity mold is so named because the material must be measured very carefully, either by weight or bulk measure, which contains the exact amount. The overflow mold does not need such careful charging with material, as it is

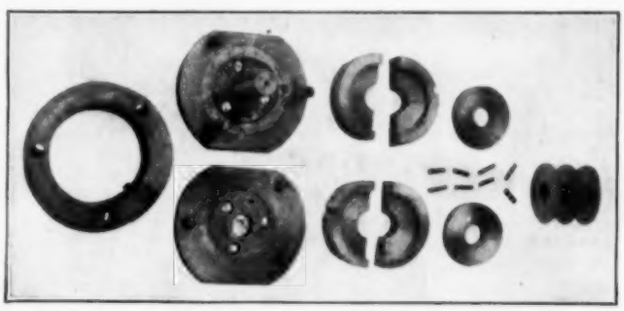


FIG. 3. FINISHED BAKELITE BOBBIN AND PARTS

designed to let the surplus material escape through channels machined between the upper and lower parts of the mold. The designing of the mold should rest entirely with the designer, who should have a practical knowledge of molding.

The part to be molded, shown in Fig. 1, is a bobbin used for electrical work. Attention is called to the oval shape of the flanges, also to the ridges, which made this part a difficult task for the designer.

This mold is difficult to fill, and it was found necessary to make biscuit out of Bakelite so as to force the material into the oval flanges. In Fig. 2 is shown a section of the mold and in Fig. 3 are shown the parts of the mold and the finished bobbin. After taking the mold apart the biscuits are inserted where the flanges are to be. The top of the mold having been put on, the mold is heated and subjected to from 15 to 25 tons' pressure for 4 min. It is then cooled for 1 min. in the cold press under the same pressure. The mold is then taken apart and the bobbin is ready for the market. The taking apart is done with a knock-out plate. The manufacturing advantage of Bakelite over hard rubber for a product of this kind is that all subsequent machining operations, such as threading, milling and drilling, are eliminated.

Calculation of Ratios for Gears

The following five pages complete the series of auxiliary tables formulated to simplify the calculation of gear train ratios.

TABLE OF RATIOS FOR GEAR TRAINS—Concluded from last week

N.	Log. N.	N.	Log. N.	N.	Log. N.	N.	Log. N.	N.	Log. N.
74 : 71	0.0179734	68 : 67	0.0064341	86 : 87	0.9949792—1	54 : 56	0.9842058—1	61 : 65	0.9724164—1
99 : 95	0.0179116	69 : 68	0.0063402	85 : 86	0.9949204—1	81 : 84	0.9842057—1	76 : 81	0.9723286—1
75 : 72	0.0177288	70 : 69	0.0062489	84 : 85	0.9948604—1	80 : 83	0.9840119—1	91 : 97	0.9722697—1
50 : 48	0.0177288	71 : 70	0.0061603	83 : 84	0.9947988—1	53 : 55	0.9839132—1	90 : 96	0.9719713—1
100 : 96	0.0177288	72 : 71	0.0060742	82 : 83	0.9947358—1	79 : 82	0.9838132—1	75 : 80	0.9719713—1
76 : 73	0.0174907	73 : 72	0.0059904	81 : 82	0.9946711—1	78 : 81	0.9836096—1	60 : 64	0.9719713—1
51 : 49	0.0173741	74 : 73	0.0059088	80 : 81	0.9946050—1	52 : 54	0.9836095—1	45 : 48	0.9719713—1
77 : 74	0.0172590	75 : 74	0.0058296	79 : 80	0.9945371—1	77 : 80	0.9834007—1	30 : 32	0.9719713—1
78 : 75	0.0170333	76 : 75	0.0057523	78 : 79	0.9944675—1	51 : 53	0.9832943—1	89 : 95	0.9716664—1
52 : 50	0.0170333	77 : 76	0.0056771	77 : 78	0.9943961—1	76 : 79	0.9831865—1	74 : 79	0.9716046—1
79 : 76	0.0168135	78 : 77	0.0056039	76 : 77	0.9943229—1	75 : 78	0.9829667—1	59 : 63	0.9715115—1
53 : 51	0.0167057	79 : 78	0.0055325	75 : 76	0.9942477—1	50 : 52	0.9829667—1	88 : 94	0.9713548—1
80 : 77	0.0165993	80 : 79	0.0054629	74 : 75	0.9941704—1	74 : 77	0.9827410—1	44 : 47	0.9713548—1
54 : 52	0.0163905	81 : 80	0.0053950	73 : 74	0.9940912—1	49 : 51	0.9826259—1	73 : 78	0.9712283—1
81 : 78	0.0163904	82 : 81	0.0053289	72 : 73	0.9940096—1	73 : 76	0.9825093—1	87 : 93	0.9710364—1
82 : 79	0.0161868	83 : 82	0.0052642	71 : 72	0.9939258—1	96 : 100	0.9822712—1	58 : 62	0.9710363—1
55 : 53	0.0160868	84 : 83	0.0052012	70 : 71	0.9938397—1	72 : 75	0.9822712—1	72 : 77	0.9708418—1
83 : 80	0.0159881	85 : 84	0.0051396	69 : 70	0.9937511—1	48 : 50	0.9822712—1	86 : 92	0.9707107—1
84 : 81	0.0157943	86 : 85	0.0050796	68 : 69	0.9936598—1	95 : 99	0.9820884—1	43 : 46	0.9707107—1
56 : 54	0.0157942	87 : 86	0.0050208	67 : 68	0.9935659—1	71 : 74	0.9820266—1	57 : 61	0.9705451—1
85 : 82	0.0156050	88 : 87	0.0049634	66 : 67	0.9934691—1	94 : 98	0.9819018—1	71 : 76	0.9704447—1
57 : 55	0.0155122	89 : 88	0.0049073	65 : 66	0.9933695—1	47 : 49	0.9819018—1	85 : 91	0.9703775—1
86 : 83	0.0154204	90 : 89	0.0048525	64 : 65	0.9932666—1	70 : 73	0.9817751—1	84 : 90	0.9700368—1
87 : 84	0.0152400	91 : 90	0.0047989	63 : 64	0.9931605—1	93 : 97	0.9817112—1	42 : 45	0.9700368—1
58 : 56	0.0152400	92 : 91	0.0047464	62 : 63	0.9930512—1	92 : 96	0.9815166—1	56 : 60	0.9700367—1
88 : 85	0.0150638	93 : 92	0.0046951	61 : 62	0.9929381—1	69 : 72	0.9815166—1	70 : 75	0.9700367—1
59 : 57	0.0149771	94 : 93	0.0046450	60 : 61	0.9928215—1	46 : 48	0.9815166—1	83 : 89	0.9696881—1
89 : 86	0.0148915	95 : 94	0.0045957	59 : 60	0.9927007—1	91 : 95	0.9813178—1	69 : 74	0.9696174—1
60 : 58	0.0147233	96 : 95	0.0045476	58 : 59	0.9925760—1	68 : 71	0.9812506—1	55 : 59	0.9695107—1
90 : 87	0.0147232	97 : 96	0.0045005	57 : 58	0.9924469—1	90 : 94	0.9811146—1	82 : 88	0.9693312—1
91 : 88	0.0145587	98 : 97	0.0044544	56 : 57	0.9923131—1	45 : 47	0.9811146—1	41 : 44	0.9693312—1
61 : 59	0.0144778	99 : 98	0.0044091	55 : 56	0.9921747—1	67 : 70	0.9809768—1	68 : 73	0.9691860—1
92 : 89	0.0143978	100 : 99	0.0043648	54 : 55	0.9920311—1	89 : 93	0.9809071—1	54 : 58	0.9689658—1
93 : 90	0.0142404	100 : 100	0.0000000	53 : 54	0.9918821—1	88 : 92	0.9806949—1	81 : 87	0.9689657—1
62 : 60	0.0142404	99 : 99	0.0000000	52 : 53	0.9917274—1	44 : 46	0.9806949—1	67 : 72	0.9687423—1
31 : 30	0.0142404	98 : 98	0.0000000	51 : 52	0.9915669—1	66 : 69	0.9806948—1	80 : 86	0.9685915—1
94 : 91	0.0140865	97 : 97	0.0000000	50 : 51	0.9913998—1	87 : 91	0.9804779—1	40 : 43	0.9685915—1
63 : 61	0.0140107	96 : 96	0.0000000	49 : 50	0.9912261—1	65 : 68	0.9804045—1	93 : 100	0.9684829—1
95 : 92	0.0139358	95 : 95	0.0000000	98 : 100	0.9912261—1	86 : 90	0.9802560—1	53 : 57	0.9684010—1
96 : 93	0.0137883	94 : 94	0.0000000	97 : 99	0.9911365—1	43 : 45	0.9802560—1	66 : 71	0.9682856—1
64 : 62	0.0137883	93 : 93	0.0000000	48 : 49	0.9910451—1	64 : 67	0.9801052—1	79 : 85	0.9682082—1
32 : 31	0.0137883	92 : 92	0.0000000	96 : 98	0.9910451—1	85 : 89	0.9800289—1	92 : 99	0.9681526—1
97 : 94	0.0136438	91 : 91	0.0000000	95 : 97	0.9909519—1	84 : 88	0.9797966—1	91 : 98	0.9678153—1
65 : 63	0.0135729	90 : 90	0.0000000	94 : 96	0.9908567—1	63 : 66	0.9797966—1	78 : 84	0.9678153—1
98 : 95	0.0135025	89 : 89	0.0000000	47 : 48	0.9908567—1	42 : 44	0.9797966—1	39 : 42	0.9678153—1
99 : 96	0.0133640	88 : 88	0.0000000	93 : 95	0.9907593—1	83 : 87	0.9795588—1	52 : 56	0.9678153—1
66 : 64	0.0133639	87 : 87	0.0000000	92 : 94	0.9906599—1	62 : 65	0.9794783—1	65 : 70	0.9678154—1
33 : 32	0.0133639	86 : 86	0.0000000	46 : 47	0.9906599—1	82 : 86	0.9793154—1	90 : 97	0.9674708—1
100 : 97	0.0132283	85 : 85	0.0000000	91 : 93	0.9905585—1	41 : 43	0.9793154—1	77 : 83	0.9674126—1
67 : 65	0.0131614	84 : 84	0.0000000	90 : 92	0.9904547—1	61 : 64	0.9791498—1	64 : 69	0.9673309—1
68 : 66	0.0129650	83 : 83	0.0000000	45 : 46	0.9904547—1	81 : 85	0.9790661—1	51 : 55	0.9672075—1
34 : 33	0.0129650	82 : 82	0.0000000	89 : 91	0.9903486—1	80 : 84	0.9788107—1	89 : 96	0.9671188—1
69 : 67	0.0127773	81 : 81	0.0000000	88 : 90	0.9902402—1	40 : 42	0.9788107—1	76 : 82	0.9669997—1
70 : 68	0.0125891	80 : 80	0.0000000	44 : 45	0.9902402—1	60 : 63	0.9788108—1	38 : 41	0.9669997—1
35 : 34	0.0125891	79 : 79	0.0000000	87 : 89	0.9901293—1	79 : 83	0.9785490—1	63 : 68	0.9668316—1
71 : 79	0.0124092	78 : 78	0.0000000	86 : 88	0.9900158—1	59 : 62	0.9784603—1	88 : 95	0.9667591—1
72 : 70	0.0122345	77 : 77	0.0000000	43 : 44	0.9900158—1	78 : 82	0.9782807—1	75 : 81	0.9665763—1
36 : 35	0.0122345	76 : 76	0.0000000	85 : 87	0.9898996—1	39 : 41	0.9782807—1	50 : 54	0.9665762—1
73 : 71	0.0120646	75 : 75	0.0000000	42 : 43	0.9897808—1	58 : 61	0.9780982—1	87 : 94	0.9663914—1
74 : 72	0.0118992	74 : 74	0.0000000	84 : 86	0.9897808—1	77 : 81	0.9780057—1	62 : 67	0.9663169—1
37 : 36	0.0118992	73 : 73	0.0000000	83 : 85	0.9896592—1	95 : 100	0.9777236—1	74 : 80	0.9661417—1
75 : 73	0.0117384	72 : 72	0.0000000	82 : 84	0.9895346—1	76 : 80	0.9777236—1	37 : 40	0.9661417—1
76 : 74	0.0115819	71 : 71	0.0000000	41 : 42	0.9895346—1	57 : 60	0.9777236—1	86 : 93	0.9660156—1
38 : 37	0.0115819	70 : 70	0.0000000	81 : 83	0.9894069—1	38 : 40	0.9777236—1	49 : 53	0.9659202—1
77 : 75	0.0114294	69 : 69	0.0000000	80 : 82	0.9892761—1	94 : 99	0.9774927—1	61 : 66	0.9657859—1
78 : 76	0.0112810	68 : 68	0.0000000	40 : 41	0.9892761—1	75 : 79	0.9774342—1	73 : 79	0.9656958—1
39 : 38	0.0112810	67 : 67	0.0000000	79 : 81	0.9891421—1	56 : 59	0.9773360—1	85 : 92	0.9656311—1
79 : 77	0.0111364	66 : 66	0.0000000	78 : 80	0.9890046—1	93 : 98	0.9772568—1	84 : 91	0.9652379—1
80 : 78	0.0109954	65 : 65	0.0000000	39 : 40	0.9890046—1	74 : 78	0.9771371—1	72 : 78	0.9652379—1
40 : 39	0.0109954	64 : 64	0.0000000	77 : 79	0.9888636—1	37 : 39	0.9771371—1	60 : 65	0.9652379—1
81 : 79	0.0108579	63 : 63	0.0000000	76 : 78	0.9887190—1	92 : 97	0.9770161—1	48 : 52	0.9652379—1
82 : 80	0.0107239	62 : 62	0.0000000	38 : 39	0.9887190—1	55 : 58	0.9769347—1	36 : 39	0.9652379—1
41 : 40	0.0107239	61 : 61	0.0000000	75 : 77	0.9885706—1	73 : 77	0.9768322—1	83 : 90	0.9648356—1
83 : 81	0.0105931	60 : 60	0.0000000	74 : 76	0.9884181—1	91 : 96	0.9767702—1	71 : 77	0.9647676—1
84 : 82	0.0104654	59 : 59	0.0000000	37 : 38	0.9884181—1	90 : 95	0.9765189—1	59 : 64	0.9646720—1
42 : 41	0.0104654	58 : 58	0.0000000	73 : 75	0.9882616—1	72 : 76	0.9765189—1	47 : 51	0.9645277—1
85 : 83	0.0103408	57 : 57	0.0000000	72 : 74	0.9881008—1	54 : 57	0.9765189—1	82 : 89	0.9644239—1
86 : 84	0.0102192	56 : 56	0.0000000	36 : 37	0.9881008—1	36 : 38	0.9765189—1	70 : 76	0.9642844—1
43 : 42	0.0102192	55 : 55	0.0000000	71 : 73	0.9879354—1	89 : 94	0.9762621—1	35 : 38	0.9642844—1
87 : 85	0.0101004	54 : 54	0.0000000	70 : 72	0.9877655—1	71 : 75	0.9761970—1	58 : 63	0.9640875—1
88 : 86	0.0099842	53 : 53	0.0000000	35 : 36	0.9877655—1	53 : 56	0.9760879—1	81 : 88	0.9640023—1
44 : 43	0.0099842	52 : 52	0.0000000	69 : 71	0.9875908—1	88 : 93	0.9759998—1	92 : 100	0.9637878—1
89 : 87	0.0098707	51 : 51	0.0000000	68 : 70	0.9874109—1	70 : 74	0.9758663—1	69 : 75	0.9637878—1
90 : 88	0.0097598	50 : 50	0.0000000	34 : 35	0.9874109—1	35 : 37	0.9758663—1	46 : 50	0.9637878—1
45 : 44	0.0097598	49 : 49	0.0000000	67 : 69	0.9872257—1	87 : 92	0.9757315—1	80 : 87	0.9635707—1
91 : 89	0.0096514	48 : 48	0.0000000	66 : 68	0.9870350—1	52 : 55	0.9756406—1	57 : 62	0.9634832—1
92 : 90	0.0095453	47 : 47	0.0000000	33 : 34	0.9870350—1	69 : 73	0.9755262—1	91 : 99	0.9634062—1
46 : 45	0.0095453	46 : 46	0.0000000	65 : 67	0.9868386—1	86 : 91	0.9754571—1	68 : 74	0.9632772—1
93 : 91	0.0094415	45 : 45	0.0000000	97 : 100	0.9867717—1	85 : 90	0.9751764—1	34 : 37	0.9632772—1
94 : 92	0.0093401	44 : 44	0.0000000	64 : 66	0.9866361—1	68 : 72	0.9751764—1	79 : 86	0.9631286—1
47 : 46	0.0093401	43 : 43	0.0000000	32 : 33	0.9866361—1	51 : 54	0.9751764—1	90 : 98	0.9630164—1
95 : 93	0.0092407	42 : 42	0.0000000	96 : 99	0.9866360—1	34 : 36	0.9751764—1	45 : 49	0.9630164—1
96 : 94	0.0091433	41 : 41	0.0000000	95 : 98	0.9864975—1	84 : 89	0.9748893—1	56 : 61	0.9628582—1
48 : 47	0.0091433	40 : 40	0.0000000	63 : 65	0.9864271—1	67 : 71	0.9748165—1	67 : 73	0.9627519—1
97 : 95	0.0090481	39 : 39	0.0000000	94 : 97	0.9863562—1	50 : 53	0.9746941—1	78 : 85	0.9626757—1
98 : 96	0.0089549	38 : 38	0.0000000	31 : 32	0.9862117—1	83 : 88	0.9745954—1	89 : 97	0.9626183—1
49 : 48	0.0089549	37 : 37	0.0000000	93 : 96	0.9862117—1	66 : 70	0.9744459—1	88 : 96	0.9622115—1
99 : 97	0.0088635	36 : 36	0.0000000	62 : 64	0.9862117—1	33 : 35	0.9744459—1	44 : 48	0.9622115—1
100 : 98	0.0087739	35 : 35	0.0000000	92 : 95	0.9860642—1	82 : 87	0.9742946—1	77 : 84	0.9622114—1
50 : 49	0.0087739	34 : 34	0.0000000	61 : 63	0.9859893—1	49 : 52	0.9741928—1	66 : 72	0.9622114—1
51 : 50	0.0086002	33 : 33	0.0000000	91 : 94	0.9859135—1	65 : 69	0.9740643—1	55 : 60	0.9622114—1
52 : 51	0.0084331	32 : 32	0.0000000	30 : 31	0.9857596—1	81 : 86	0.9739865—1	33 : 36	0.9622114—1
53 : 52	0.0082726	31 : 31	0.0000000	60 : 62	0.9857596—1	80 : 85	0.9736711—1	87 : 95	0.9617957—1
54 : 53	0.0081179	30 : 30	0.0000000	90 : 93	0.9857596—1	64 : 68	0.9736711—1	76 : 83	0.9617355—1
55 : 54	0.0079689	99 : 100	0.9956352—1	89 : 92	0.9856022—1	32 : 34	0.9736711—1	65 : 71	0.9616551—1
56 : 55	0.0078253	98 : 99	0.9955090—1	59 : 61	0.9855222—1	48 : 51	0.9736710—1	54 : 59	0.9615418—1
57 : 56	0.0076869	97 : 98	0.9954456—1	88 : 91	0.9854413—1	79 : 84	0.9733478—1	86 : 94	0.9613706—1
58 : 57	0.0075531	96 : 97	0.9954995—1	87 : 90	0.9852768—1	63 : 67	0.9732657—1	43 : 47	0.9613706—1
59 : 58	0.0078240	95 : 96	0.9954524—1	58 : 60	0.9852767—1	94 : 100	0.9731279—1	75 : 82	0.9612474—1
60 : 59	0.0072093	94 : 95	0.9954043—1	86 : 89	0.9851085—1	47 : 50	0.9731279—1	64 : 70	0.9610820—1
61 : 60	0.0071785	93 : 94	0.9953550—1	57 : 59	0.9850229—1	78 : 83	0.9730165—1	32 : 35	0.9610820—1
62 : 61	0.0070619	92 : 93	0.9953049—1	85 : 88	0.9849362—1	62 : 66	0.9728478—1	85 : 93	0.9609360—1
63 : 62	0.0069488	91 : 92	0.9952536—1	84 : 87	0.9847600—1	31 : 33	0.9728478—1	53 : 58	0.9608479—1
64 : 63	0.0068395	90 : 91	0.9952011—1	56 : 58	0.9847600—1	93 : 99	0.9728477—1	74 : 81	0.9607467—1
65 : 64	0.0067334	89 : 90	0.9951475—1	83 : 86	0.9845796—1	77 : 82	0.9726768—1	42 : 46	0.9604015—1
66 : 65	0.0066305	88 : 89	0.9950927—1	55 : 57	0.9844878—1	46 : 49	0.9725617—1	84 : 92	0.9604015—1
67 : 66	0.0065309	87 : 88	0.9950366—1	82 : 85	0.9843950—1	92 : 98	0.9725617—1	63 : 69	0.9604914—1

TABLE OF RATIOS FOR GEAR TRAINS—Continued

N.	Log. N.	N.	Log. N.	N.	Log. N.	N.	Log. N.	N.	Log. N.
73 : 80	0.9602329—1	86 : 97	0.9477268—1	74 : 86	0.9347332—1	75 : 90	0.9208188—1	42 : 52	0.9072460—1
52 : 57	0.9601284—1	78 : 88	0.9476119—1	80 : 93	0.9346071—1	65 : 78	0.9208188—1	63 : 78	0.9072459—1
83 : 91	0.9600367—1	39 : 44	0.9476119—1	86 : 100	0.9344985—1	60 : 72	0.9208188—1	67 : 83	0.9069967—1
31 : 34	0.9598828—1	70 : 79	0.9474709—1	43 : 50	0.9344985—1	55 : 66	0.9208188—1	46 : 57	0.9068829—1
62 : 68	0.9598828—1	62 : 70	0.9472937—1	49 : 57	0.9343212—1	40 : 48	0.9208188—1	71 : 88	0.9067756—1
72 : 79	0.9597054—1	31 : 35	0.9472937—1	55 : 64	0.9341827—1	30 : 36	0.9208188—1	75 : 93	0.9065784—1
82 : 90	0.9595714—1	85 : 96	0.9471477—1	61 : 71	0.9340715—1	70 : 84	0.9208187—1	50 : 62	0.9065783—1
41 : 45	0.9595714—1	54 : 61	0.9470640—1	67 : 78	0.9339802—1	50 : 60	0.9208187—1	79 : 98	0.9064010—1
51 : 56	0.9593822—1	77 : 87	0.9469714—1	73 : 85	0.9339040—1	45 : 54	0.9208187—1	54 : 67	0.9063190—1
61 : 67	0.9592550—1	69 : 78	0.9467545—1	79 : 92	0.9338393—1	35 : 42	0.9208187—1	58 : 72	0.9060955—1
71 : 78	0.9591637—1	46 : 52	0.9467545—1	85 : 99	0.9337837—1	79 : 95	0.9199035—1	62 : 77	0.9059010—1
81 : 89	0.9590950—1	84 : 95	0.9465557—1	84 : 98	0.9330532—1	74 : 89	0.9198417—1	66 : 82	0.9057300—1
91 : 100	0.9590414—1	61 : 69	0.9464807—1	78 : 91	0.9330532—1	69 : 83	0.9197710—1	33 : 41	0.9057300—1
60 : 66	0.9586074—1	76 : 86	0.9463151—1	72 : 84	0.9330532—1	64 : 77	0.9196893—1	70 : 87	0.9055787—1
30 : 33	0.9586074—1	38 : 43	0.9463151—1	66 : 77	0.9330532—1	59 : 71	0.9195937—1	74 : 92	0.9054439—1
90 : 99	0.9586073—1	53 : 60	0.9461246—1	60 : 70	0.9330532—1	54 : 65	0.9194804—1	37 : 46	0.9054439—1
80 : 88	0.9586073—1	68 : 77	0.9460182—1	54 : 63	0.9330532—1	49 : 59	0.9193441—1	78 : 97	0.9053229—1
70 : 77	0.9586073—1	83 : 94	0.9459502—1	48 : 56	0.9330532—1	44 : 53	0.9191768—1	41 : 51	0.9052137—1
50 : 55	0.9586073—1	75 : 85	0.9456424—1	42 : 49	0.9330532—1	83 : 100	0.9190781—1	45 : 56	0.9050245—1
40 : 44	0.9586073—1	60 : 68	0.9456424—1	36 : 42	0.9330532—1	78 : 94	0.9189667—1	49 : 61	0.9048663—1
89 : 98	0.9581639—1	30 : 34	0.9456424—1	30 : 35	0.9330532—1	39 : 47	0.9189667—1	53 : 66	0.9047320—1
79 : 87	0.9581078—1	45 : 51	0.9456423—1	83 : 97	0.9323064—1	73 : 88	0.9188402—1	57 : 71	0.9046166—1
69 : 76	0.9580355—1	82 : 93	0.9453310—1	77 : 90	0.9322482—1	68 : 82	0.9186950—1	61 : 76	0.9045162—1
59 : 65	0.9579386—1	67 : 76	0.9452612—1	71 : 83	0.9321802—1	34 : 41	0.9186950—1	65 : 81	0.9044284—1
49 : 54	0.9578023—1	52 : 59	0.9451513—1	65 : 76	0.9320098—1	63 : 76	0.9185269—1	69 : 86	0.9043506—1
88 : 97	0.9577110—1	74 : 84	0.9449524—1	59 : 69	0.9320029—1	58 : 70	0.9183300—1	73 : 91	0.9042815—1
78 : 86	0.9575961—1	37 : 42	0.9449524—1	53 : 62	0.9318842—1	82 : 99	0.9181787—1	77 : 96	0.9042195—1
39 : 43	0.9575961—1	59 : 67	0.9447772—1	47 : 55	0.9317352—1	53 : 64	0.9180959—1	80 : 100	0.9030900—1
68 : 75	0.9574476—1	81 : 92	0.9446972—1	82 : 96	0.9315427—1	77 : 93	0.9180078—1	76 : 95	0.9030900—1
87 : 96	0.9572481—1	88 : 100	0.9444827—1	41 : 48	0.9315427—1	72 : 87	0.9178132—1	72 : 90	0.9030900—1
58 : 64	0.9572480—1	44 : 50	0.9444827—1	76 : 89	0.9314236—1	48 : 58	0.9178132—1	68 : 85	0.9030900—1
77 : 85	0.9570718—1	66 : 75	0.9444827—1	70 : 82	0.9312841—1	67 : 81	0.9175898—1	64 : 80	0.9030900—1
48 : 53	0.9569653—1	73 : 83	0.9442448—1	35 : 41	0.9312841—1	43 : 52	0.9174652—1	60 : 75	0.9030900—1
67 : 74	0.9568431—1	51 : 58	0.9441422—1	64 : 75	0.9311187—1	62 : 75	0.9173304—1	56 : 70	0.9030900—1
86 : 95	0.9567749—1	80 : 91	0.9440486—1	58 : 68	0.9309191—1	81 : 98	0.9172589—1	44 : 55	0.9030900—1
57 : 63	0.9565344—1	87 : 99	0.9438841—1	81 : 95	0.9307614—1	76 : 92	0.9170258—1	40 : 50	0.9030900—1
76 : 84	0.9565343—1	58 : 66	0.9438841—1	52 : 61	0.9306735—1	57 : 69	0.9170258—1	36 : 45	0.9030900—1
38 : 42	0.9565343—1	65 : 74	0.9436817—1	75 : 88	0.9305786—1	38 : 46	0.9170258—1	32 : 40	0.9030900—1
85 : 94	0.9562910—1	72 : 82	0.9435786—1	69 : 81	0.9303641—1	71 : 86	0.9167598—1	52 : 65	0.9030899—1
66 : 73	0.9562210—1	36 : 41	0.9435186—1	46 : 54	0.9303640—1	52 : 63	0.9166628—1	48 : 60	0.9030899—1
47 : 52	0.9560946—1	79 : 90	0.9433846—1	63 : 74	0.9301088—1	66 : 80	0.9164539—1	79 : 99	0.9019919—1
75 : 83	0.9559832—1	86 : 98	0.9432724—1	80 : 94	0.9299621—1	33 : 40	0.9164539—1	75 : 94	0.9019334—1
84 : 93	0.9557964—1	43 : 49	0.9432724—1	40 : 47	0.9299621—1	80 : 97	0.9163183—1	71 : 89	0.9018683—1
56 : 62	0.9557963—1	50 : 57	0.9430951—1	57 : 67	0.9298001—1	47 : 57	0.9162230—1	67 : 84	0.9017955—1
65 : 72	0.9558809—1	57 : 65	0.9429615—1	74 : 87	0.9297124—1	61 : 74	0.9160981—1	63 : 79	0.9017134—1
74 : 82	0.9554178—1	64 : 73	0.9428571—1	85 : 100	0.9294189—1	75 : 91	0.9160199—1	59 : 74	0.9016203—1
37 : 41	0.9554178—1	71 : 81	0.9427733—1	68 : 80	0.9294189—1	70 : 85	0.9156791—1	55 : 69	0.9015136—1
83 : 92	0.9552903—1	78 : 89	0.9427046—1	51 : 60	0.9294189—1	56 : 68	0.9156791—1	51 : 64	0.9013902—1
46 : 51	0.9551876—1	85 : 97	0.9426472—1	34 : 40	0.9294189—1	42 : 51	0.9156791—1	47 : 59	0.9012459—1
55 : 61	0.9550329—1	87 : 96	0.9420080—1	79 : 93	0.9291442—1	79 : 96	0.9153559—1	43 : 54	0.9010747—1
64 : 71	0.9549217—1	77 : 88	0.9420080—1	62 : 73	0.9290688—1	65 : 79	0.9152863—1	78 : 98	0.9008685—1
73 : 81	0.9548379—1	70 : 80	0.9420080—1	45 : 53	0.9289366—1	51 : 62	0.9151785—1	39 : 49	0.9008685—1
82 : 91	0.9547725—1	63 : 72	0.9420080—1	73 : 86	0.9288244—1	74 : 90	0.9149892—1	74 : 93	0.9007488—1
90 : 100	0.9542425—1	56 : 64	0.9420080—1	84 : 99	0.9286441—1	37 : 45	0.9149892—1	70 : 88	0.9006153—1
81 : 90	0.9542425—1	49 : 56	0.9420080—1	56 : 66	0.9286441—1	60 : 73	0.9148284—1	35 : 44	0.9006153—1
72 : 80	0.9542425—1	42 : 48	0.9420080—1	67 : 79	0.9284477—1	69 : 84	0.9145098—1	66 : 83	0.9004658—1
63 : 70	0.9542425—1	35 : 40	0.9420080—1	78 : 92	0.9283068—1	46 : 56	0.9145098—1	62 : 78	0.9002971—1
54 : 60	0.9542425—1	83 : 95	0.9413545—1	39 : 46	0.9283068—1	78 : 95	0.9143710—1	31 : 39	0.9002971—1
45 : 50	0.9542425—1	76 : 87	0.9412943—1	50 : 59	0.9281180—1	55 : 67	0.9142879—1	58 : 73	0.9001051—1
36 : 40	0.9542425—1	69 : 79	0.9412220—1	61 : 72	0.9279973—1	64 : 78	0.9140854—1	54 : 68	0.8998849—1
89 : 99	0.9537548—1	62 : 71	0.9411334—1	72 : 85	0.9279136—1	32 : 39	0.9140854—1	77 : 97	0.8997190—1
80 : 89	0.9537000—1	55 : 63	0.9410222—1	83 : 98	0.9278520—1	73 : 89	0.9139329—1	50 : 63	0.8996295—1
71 : 79	0.9536312—1	48 : 55	0.9408785—1	77 : 91	0.9274493—1	82 : 100	0.9138139—1	73 : 92	0.8995351—1
62 : 69	0.9535426—1	82 : 94	0.9406860—1	66 : 78	0.9274493—1	41 : 50	0.9138139—1	69 : 87	0.8993298—1
53 : 59	0.9534239—1	41 : 47	0.9406860—1	55 : 65	0.9274493—1	50 : 61	0.9136402—1	46 : 58	0.8993298—1
88 : 98	0.9532566—1	75 : 86	0.9405628—1	44 : 52	0.9274493—1	59 : 72	0.9135195—1	65 : 82	0.8990995—1
44 : 49	0.9532566—1	68 : 78	0.9404143—1	33 : 39	0.9274493—1	68 : 83	0.9134308—1	42 : 53	0.8989734—1
79 : 88	0.9531444—1	34 : 39	0.9404143—1	82 : 97	0.9270422—1	77 : 94	0.9133628—1	61 : 77	0.8988391—1
70 : 78	0.9530034—1	61 : 70	0.9402318—1	71 : 84	0.9269790—1	54 : 66	0.9128499—1	76 : 96	0.8985424—1
35 : 39	0.9530034—1	81 : 93	0.9400021—1	60 : 71	0.9268930—1	81 : 99	0.9128498—1	57 : 72	0.8985424—1
61 : 68	0.9528209—1	54 : 62	0.9400021—1	49 : 58	0.9267681—1	72 : 88	0.9128498—1	38 : 48	0.8985424—1
87 : 97	0.9527476—1	74 : 85	0.9398128—1	76 : 90	0.9265711—1	63 : 77	0.9128498—1	72 : 91	0.8982911—1
78 : 87	0.9525753—1	47 : 54	0.9397041—1	38 : 45	0.9265711—1	45 : 55	0.9128498—1	53 : 67	0.8982011—1
52 : 58	0.9525753—1	67 : 77	0.9395841—1	65 : 77	0.9264227—1	36 : 44	0.9128498—1	68 : 86	0.8980104—1
69 : 77	0.9523584—1	87 : 100	0.9395193—1	81 : 96	0.9262138—1	76 : 93	0.9123307—1	34 : 43	0.8980104—1
86 : 96	0.9522273—1	80 : 92	0.9393022—1	54 : 64	0.9262138—1	67 : 82	0.9122609—1	49 : 62	0.8978044—1
43 : 48	0.9522273—1	60 : 69	0.9393022—1	70 : 83	0.9260199—1	58 : 71	0.9121697—1	64 : 81	0.8976950—1
60 : 67	0.9520765—1	40 : 46	0.9393022—1	43 : 51	0.9258983—1	49 : 60	0.9120448—1	79 : 100	0.8976271—1
77 : 86	0.9519922—1	73 : 84	0.9390436—1	59 : 70	0.9257540—1	80 : 98	0.9118639—1	75 : 95	0.8973377—1
85 : 95	0.9516953—1	53 : 61	0.9389461—1	75 : 89	0.9256713—1	40 : 49	0.9118639—1	60 : 76	0.8973377—1
68 : 76	0.9516953—1	86 : 99	0.9388633—1	80 : 95	0.9253664—1	71 : 87	0.9117390—1	30 : 38	0.8973377—1
51 : 57	0.9516953—1	33 : 38	0.9387303—1	64 : 76	0.9253664—1	62 : 76	0.9115781—1	45 : 57	0.8973376—1
34 : 38	0.9516953—1	66 : 76	0.9387303—1	32 : 38	0.9253664—1	31 : 38	0.9115781—1	71 : 90	0.8970158—1
76 : 85	0.9513947—1	79 : 91	0.9385857—1	48 : 57	0.9253663—1	53 : 65	0.9113625—1	56 : 71	0.8969297—1
59 : 66	0.9513081—1	46 : 53	0.9384819—1	69 : 82	0.9250352—1	75 : 92	0.9112735—1	41 : 52	0.8967806—1
84 : 94	0.9511514—1	59 : 68	0.9383431—1	53 : 63	0.9249354—1	66 : 81	0.9110589—1	67 : 85	0.8966559—1
42 : 47	0.9511514—1	72 : 83	0.9382544—1	74 : 88	0.9247490—1	44 : 54	0.9110589—1	78 : 99	0.8964594—1
67 : 75	0.9510135—1	85 : 98	0.9381928—1	37 : 44	0.9247490—1	79 : 97	0.9108554—1	52 : 66	0.8964594—1
75 : 84	0.9507820—1	78 : 90	0.9378521—1	58 : 69	0.9245780—1	57 : 70	0.9107709—1	63 : 80	0.8962505—1
50 : 56	0.9507820—1	65 : 75	0.9378521—1	79 : 94	0.9244992—1	70 : 86	0.9105995—1	74 : 94	0.8961038—1
83 : 93	0.9505952—1	39 : 45	0.9378521—1	84 : 100	0.9242793—1	35 : 43	0.9105995—1	37 : 47	0.8961038—1
58 : 65	0.9505146—1	52 : 60	0.9378520—1	42 : 50	0.9242793—1	48 : 59	0.9103892—1	48 : 61	0.8959114—1
66 : 74	0.9503122—1	84 : 97	0.9375076—1	63 : 75	0.9242792—1	61 : 75	0.9102685—1	59 : 75	0.8957907—1
33 : 37	0.9503122—1	71 : 82	0.9374444—1	68 : 81	0.9240239—1	74 : 91	0.9101903—1	70 : 89	0.8957080—1
74 : 83	0.9501536—1	58 : 67	0.9373532—1	47 : 56	0.9239099—1	78 : 96	0.9098234—1	55 : 70	0.8952647—1
82 : 92	0.9500261—1	45 : 52	0.9372092—1	73 : 87	0.9238036—1	65 : 80	0.9098234—1	44 : 56	0.8952647—1
41 : 46	0.9500261—1	77 : 89	0.9371007—1	78 : 93	0.9236117—1	39 : 48	0.9098234—1	77 : 98	0.8952646—1
49 : 55	0.9498334—1	64 : 74	0.9369483—1	52 : 62	0.9236116—1	52 : 64	0.9098233—1	66 : 84	0.8952646—1
57 : 64	0.9496949—1	32 : 37	0.9369483—1	83 : 99	0.9234429—1	69 : 85	0.9094302—1	33 : 42	0.8952646—1
65 : 73	0.9495905—1	83 : 96	0.9368069—1	57 : 68	0.9233660—1	56 : 69	0.9093389—1	73 : 93	0.8948400—1
73 : 82	0.9495090—1	51 : 59	0.9367182—1	62 : 74	0.9231600—1	43 : 53	0.9091926—1	62 : 79	0.8947646—1
81 : 91	0.9494436—1	70 : 81	0.9366130—1	31 : 37	0.9231600—1	73 : 90	0.9090804—1	51 : 65	0.8946568—1
89 : 100	0.9493900—1	57 : 66	0.9363310—1	67 : 80	0.9229848—1	60 : 74	0.9089196—1	40 : 51	0.8944898—1
88 : 99	0.9488475—1	76 : 88	0.9363309—1	72 : 86	0.9228340—1	30 : 37	0.9089196—1	69 : 88	0.8943664—1
72 : 81	0.9488475—1	38 : 44	0.9363309—1	36 : 43	0.9228340—1	77 : 95	0.9087671—1	58 : 74	0.8941963—1
64 : 72	0.9488475—1	82 : 95	0.9360903—1	77 : 92	0.9227029—1	47 : 58	0.9086699—1	76 : 97	0.8940419—1
56 : 63	0.9488475—1	63 : 73	0.9360176—1	82 : 98	0.9225878—1	64 : 79	0.9085529—1	47 : 60	0.8939466—1
40 : 45	0.9488475—1	44 : 51	0.9358825—1	41 : 49	0.9225878—1	81 : 100	0.9084850—1	65 : 83	0.8938353—1
32 : 36	0.9488475—1	69 : 80	0.9357591—1	46 : 55	0.9223951—1	51 : 63	0.9082297—1	72 : 92	0.8935447—1
80 : 90	0.9488475—1	75 : 87	0.9355420—1	51 : 61	0.9222404—1	68 : 84	0.9082296—1	54 : 69	0.8935447—1
48 : 54	0.9488475—1	50 : 58	0.9355420—1	56 : 67	0.9221132—1	34 : 42	0.9082296—1	36 : 46	0.8935447—1
87 : 98	0.9482932—1	81 : 94	0.9353571—1	61 : 73	0.9220069—1	72 : 80	0.9079425—1	61 : 78	0.8932352—1
79 : 89	0.9482371—1	56 : 65	0.9352746—1	66 : 79	0.9219168—1	55 : 68	0.9078538—1	43 : 55	0.8931058—1
71 : 80	0.9481683—1	62 : 72	0.9350592—1	71 : 85	0.9218394—1	76 : 94	0.9066857—1	68 : 87	0.8929896—1
63 : 71	0.9480822—1	31 : 36	0.9350592—1	76 : 91	0.9217722—1	38 : 47	0.9076857—1	75 : 96	0.8927901—1
55 : 62	0.9479710—1	68 : 79	0.9348818—1	81 : 97	0.9217133—1	59 : 73	0.9075291—1	50 : 64	0.8927900—1
47 : 53	0.9478220—1	37 : 43	0.9347332—1	80 : 96	0.9208188—1	80 : 99	0.9074548—1	57 : 73	0.8925520—1

TABLE OF RATIOS FOR GEAR TRAINS—Continued

N.	Log. N.	N.	Log. N.	N.	Log. N.	N.	Log. N.	N.	Log. N.
32 : 41	0.8923661—1	52 : 69	0.8771542—1	61 : 84	0.8610505—1	37 : 53	0.8439258—1	61 : 91	0.8262884—1
64 : 82	0.8923661—1	55 : 73	0.8770398—1	53 : 73	0.8609530—1	67 : 96	0.8438036—1	63 : 94	0.8262126—1
71 : 91	0.8922169—1	58 : 77	0.8769373—1	45 : 62	0.8608208—1	30 : 43	0.8436528—1	65 : 97	0.8261417—1
78 : 100	0.8920946—1	61 : 81	0.8768448—1	37 : 51	0.8606315—1	60 : 86	0.8436528—1	67 : 100	0.8260748—1
39 : 50	0.8920946—1	64 : 85	0.8767611—1	66 : 91	0.8605025—1	53 : 76	0.8434623—1	64 : 96	0.8239088—1
46 : 59	0.8919058—1	67 : 89	0.8760848—1	58 : 80	0.8603380—1	69 : 99	0.8432139—1	62 : 93	0.8239088—1
53 : 68	0.8917670—1	70 : 93	0.8766151—1	50 : 69	0.8601209—1	46 : 66	0.8432139—1	60 : 90	0.8239088—1
60 : 77	0.8916606—1	73 : 97	0.8765512—1	71 : 98	0.8600322—1	62 : 89	0.8430017—1	30 : 45	0.8239088—1
67 : 86	0.8915763—1	75 : 100	0.8750613—1	42 : 58	0.8598213—1	39 : 56	0.8428766—1	54 : 81	0.8239088—1
74 : 95	0.8915081—1	72 : 96	0.8750613—1	63 : 87	0.8598212—1	55 : 79	0.8427356—1	44 : 66	0.8239088—1
77 : 99	0.8908555—1	69 : 92	0.8750613—1	55 : 76	0.8595491—1	64 : 92	0.8423922—1	42 : 63	0.8239088—1
70 : 90	0.8908555—1	66 : 80	0.8750613—1	68 : 94	0.8593810—1	32 : 46	0.8423922—1	32 : 48	0.8239088—1
63 : 81	0.8908555—1	57 : 76	0.8750613—1	34 : 47	0.8593810—1	48 : 69	0.8423921—1	66 : 99	0.8239087—1
56 : 72	0.8908555—1	54 : 72	0.8750613—1	47 : 65	0.8591845—1	57 : 82	0.8420610—1	58 : 87	0.8239087—1
42 : 54	0.8908555—1	51 : 68	0.8750613—1	60 : 83	0.8590732—1	41 : 59	0.8419319—1	56 : 84	0.8239087—1
35 : 45	0.8908555—1	30 : 40	0.8750613—1	65 : 90	0.8586709—1	66 : 95	0.8418203—1	52 : 78	0.8239087—1
49 : 63	0.8908556—1	42 : 56	0.8750613—1	52 : 72	0.8586708—1	50 : 72	0.8416375—1	50 : 75	0.8239087—1
73 : 94	0.8901950—1	39 : 52	0.8750613—1	39 : 54	0.8586708—1	59 : 85	0.8414331—1	48 : 72	0.8239087—1
66 : 85	0.8901250—1	36 : 48	0.8750613—1	70 : 97	0.8583263—1	68 : 98	0.8412828—1	46 : 69	0.8239087—1
59 : 76	0.8900384—1	66 : 88	0.8750612—1	57 : 79	0.8582478—1	34 : 49	0.8412828—1	40 : 60	0.8239087—1
52 : 67	0.8899285—1	63 : 84	0.8750612—1	44 : 61	0.8581229—1	43 : 62	0.8410768—1	38 : 57	0.8239087—1
45 : 58	0.8897845—1	48 : 64	0.8750612—1	62 : 86	0.8578932—1	52 : 75	0.8409420—1	36 : 54	0.8239087—1
76 : 98	0.8895875—1	45 : 60	0.8750612—1	31 : 43	0.8578932—1	61 : 88	0.8408471—1	34 : 51	0.8239087—1
38 : 49	0.8895875—1	33 : 44	0.8750612—1	49 : 68	0.8576872—1	36 : 52	0.8402992—1	65 : 98	0.8216873—1
69 : 89	0.8894591—1	74 : 99	0.8735965—1	67 : 93	0.8575919—1	54 : 78	0.8402992—1	63 : 95	0.8216169—1
62 : 80	0.8893017—1	71 : 95	0.8735347—1	72 : 100	0.8573325—1	63 : 91	0.8402991—1	61 : 92	0.8215420—1
31 : 40	0.8893017—1	68 : 91	0.8734675—1	54 : 75	0.8573325—1	45 : 65	0.8402991—1	59 : 89	0.8214620—1
55 : 71	0.8891044—1	65 : 87	0.8733941—1	36 : 50	0.8573325—1	65 : 94	0.8397855—1	57 : 86	0.8213764—1
72 : 93	0.8888496—1	32 : 83	0.8733136—1	59 : 82	0.8570381—1	56 : 81	0.8397030—1	55 : 83	0.8212846—1
48 : 62	0.8888495—1	59 : 79	0.8732249—1	41 : 57	0.8569090—1	47 : 68	0.8395890—1	53 : 80	0.8211859—1
65 : 84	0.8886341—1	56 : 75	0.8731267—1	64 : 89	0.8567900—1	38 : 55	0.8394209—1	51 : 77	0.8210795—1
41 : 53	0.8885080—1	53 : 71	0.8730176—1	69 : 96	0.8565779—1	67 : 97	0.8393031—1	49 : 74	0.8209644—1
58 : 75	0.8883667—1	50 : 67	0.8728952—1	46 : 64	0.8565778—1	58 : 84	0.8391487—1	47 : 71	0.8208396—1
75 : 97	0.8882896—1	47 : 63	0.8727574—1	51 : 71	0.8563119—1	49 : 71	0.8389378—1	45 : 68	0.8207036—1
51 : 66	0.8880263—1	44 : 59	0.8726007—1	56 : 78	0.8560934—1	69 : 100	0.8388491—1	43 : 65	0.8205551—1
68 : 88	0.8880262—1	41 : 55	0.8724212—1	61 : 85	0.8559100—1	60 : 87	0.8386320—1	41 : 62	0.8203922—1
34 : 44	0.8880262—1	38 : 51	0.8722134—1	66 : 92	0.8557561—1	40 : 58	0.8386320—1	39 : 59	0.8202126—1
61 : 79	0.8877027—1	73 : 98	0.8720968—1	33 : 46	0.8557561—1	51 : 74	0.8383385—1	37 : 56	0.8200137—1
44 : 57	0.8875778—1	70 : 94	0.8719701—1	71 : 99	0.8556231—1	62 : 90	0.8381492—1	35 : 53	0.8197921—1
71 : 92	0.8874705—1	35 : 47	0.8719701—1	38 : 53	0.8555077—1	31 : 45	0.8381492—1	66 : 100	0.8195439—1
54 : 70	0.8872958—1	67 : 90	0.8718323—1	43 : 60	0.8553172—1	42 : 61	0.8379195—1	33 : 50	0.8195439—1
64 : 83	0.8871019—1	64 : 86	0.8716815—1	48 : 67	0.8551664—1	53 : 77	0.8377852—1	64 : 97	0.8194083—1
74 : 96	0.8869605—1	32 : 43	0.8716815—1	53 : 74	0.8550442—1	64 : 93	0.8376971—1	62 : 94	0.8192638—1
37 : 48	0.8869605—1	61 : 82	0.8715159—1	58 : 81	0.8549430—1	66 : 96	0.8372727—1	31 : 47	0.8192638—1
47 : 61	0.8867681—1	58 : 78	0.8713334—1	63 : 88	0.8548578—1	55 : 80	0.8372727—1	60 : 91	0.8191099—1
57 : 74	0.8866432—1	55 : 74	0.8711310—1	68 : 95	0.8547853—1	44 : 64	0.8372727—1	58 : 88	0.8189453—1
67 : 87	0.8865555—1	52 : 70	0.8709053—1	65 : 91	0.8538720—1	33 : 48	0.8372727—1	56 : 85	0.8187691—1
77 : 100	0.8864907—1	49 : 66	0.8706522—1	60 : 84	0.8538720—1	68 : 99	0.8368737—1	54 : 82	0.8185799—1
60 : 78	0.8860567—1	72 : 97	0.8705608—1	55 : 77	0.8538720—1	57 : 83	0.8367968—1	52 : 79	0.8183762—1
40 : 52	0.8860567—1	69 : 93	0.8703662—1	50 : 70	0.8538720—1	46 : 67	0.8366830—1	50 : 76	0.8181564—1
80 : 39	0.8860567—1	46 : 62	0.8703661—1	45 : 63	0.8538720—1	35 : 51	0.8364978—1	48 : 73	0.8179183—1
70 : 91	0.8860566—1	66 : 89	0.8701539—1	40 : 56	0.8538720—1	89 : 86	0.8363535—1	46 : 70	0.8176598—1
50 : 65	0.8860566—1	43 : 58	0.8700405—1	30 : 42	0.8538720—1	48 : 70	0.8361432—1	44 : 67	0.8173779—1
73 : 95	0.8855993—1	63 : 85	0.8699216—1	70 : 98	0.8538719—1	61 : 89	0.8359398—1	65 : 99	0.8172782—1
63 : 82	0.8855266—1	60 : 81	0.8696663—1	35 : 49	0.8538719—1	37 : 54	0.8358079—1	63 : 96	0.8170693—1
53 : 69	0.8854268—1	40 : 54	0.8696662—1	67 : 94	0.8529469—1	50 : 73	0.8356471—1	42 : 64	0.8170693—1
43 : 56	0.8852805—1	57 : 77	0.8693842—1	62 : 87	0.8528724—1	63 : 92	0.8355527—1	61 : 93	0.8168469—1
76 : 99	0.8851784—1	74 : 100	0.8692317—1	57 : 80	0.8527849—1	65 : 95	0.8351898—1	40 : 61	0.8167302—1
66 : 86	0.8850454—1	37 : 50	0.8692317—1	52 : 73	0.8526804—1	52 : 76	0.8351897—1	59 : 90	0.8166095—1
33 : 43	0.8850454—1	54 : 73	0.8690709—1	47 : 66	0.8525540—1	39 : 57	0.8351897—1	57 : 87	0.8163556—1
50 : 73	0.8848651—1	71 : 96	0.8689871—1	42 : 59	0.8523973—1	67 : 98	0.8348487—1	38 : 58	0.8163556—1
69 : 90	0.8846066—1	68 : 92	0.8687211—1	37 : 52	0.8521984—1	54 : 79	0.8347667—1	55 : 84	0.8160834—1
46 : 60	0.8846065—1	51 : 69	0.8687211—1	69 : 97	0.8520774—1	41 : 60	0.8346326—1	36 : 55	0.8159398—1
59 : 77	0.8843613—1	34 : 46	0.8687211—1	64 : 90	0.8519375—1	56 : 82	0.8343741—1	53 : 81	0.8157909—1
72 : 94	0.8842046—1	65 : 88	0.8684307—1	32 : 45	0.8519375—1	43 : 63	0.8341280—1	51 : 78	0.8154756—1
36 : 47	0.8842046—1	48 : 65	0.8683278—1	59 : 83	0.8517739—1	58 : 85	0.8340091—1	34 : 52	0.8154756—1
49 : 64	0.8840161—1	31 : 42	0.8681124—1	54 : 76	0.8515802—1	60 : 88	0.8336686—1	49 : 75	0.8151348—1
62 : 81	0.8839067—1	62 : 84	0.8681124—1	49 : 69	0.8513470—1	30 : 44	0.8336686—1	64 : 98	0.8149539—1
75 : 98	0.8838352—1	45 : 61	0.8678827—1	71 : 100	0.8512583—1	45 : 66	0.8336686—1	32 : 49	0.8149529—1
65 : 85	0.8834945—1	59 : 80	0.8677620—1	66 : 93	0.8510610—1	62 : 91	0.8333503—1	47 : 72	0.8147654—1
52 : 68	0.8834944—1	73 : 99	0.8676877—1	44 : 62	0.8510610—1	47 : 69	0.8332488—1	62 : 95	0.8146681—1
39 : 51	0.8834944—1	70 : 95	0.8673744—1	61 : 86	0.8508313—1	64 : 94	0.8330521—1	60 : 92	0.8143635—1
68 : 89	0.8831189—1	50 : 76	0.8673744—1	39 : 55	0.8507019—1	32 : 47	0.8330521—1	30 : 46	0.8143635—1
55 : 72	0.8830302—1	42 : 57	0.8673744—1	56 : 79	0.8505609—1	49 : 72	0.8328636—1	45 : 69	0.8143634—1
42 : 55	0.8828866—1	67 : 91	0.8670334—1	68 : 96	0.8502377—1	66 : 97	0.8327722—1	58 : 89	0.8140380—1
71 : 93	0.8827754—1	53 : 72	0.8669434—1	51 : 72	0.8502377—1	68 : 100	0.8325089—1	43 : 66	0.8139246—1
58 : 76	0.8826144—1	39 : 53	0.8667887—1	34 : 48	0.8502377—1	51 : 75	0.8325089—1	56 : 86	0.8136895—1
74 : 97	0.8824600—1	64 : 87	0.8666907—1	63 : 89	0.8499505—1	34 : 50	0.8325089—1	41 : 63	0.8134434—1
45 : 59	0.8823605—1	50 : 68	0.8664611—1	46 : 65	0.8498444—1	53 : 78	0.8321813—1	54 : 83	0.8133157—1
61 : 80	0.8822308—1	61 : 83	0.8662517—1	58 : 82	0.8496141—1	36 : 53	0.8320266—1	65 : 100	0.8129134—1
64 : 84	0.8819007—1	72 : 98	0.8661064—1	70 : 99	0.8494628—1	55 : 81	0.8318777—1	52 : 80	0.8129133—1
48 : 63	0.8819007—1	36 : 49	0.8661064—1	41 : 58	0.8493559—1	57 : 84	0.8315956—1	39 : 60	0.8129133—1
32 : 42	0.8819007—1	47 : 64	0.8679179—1	53 : 75	0.4492146—1	38 : 56	0.8315956—1	63 : 97	0.8125688—1
67 : 88	0.8815021—1	58 : 79	0.8658009—1	65 : 92	0.8491256—1	50 : 87	0.8313327—1	50 : 77	0.8124793—1
51 : 67	0.8814954—1	69 : 94	0.9657212—1	60 : 85	0.8487324—1	40 : 59	0.8312080—1	37 : 57	0.8123268—1
70 : 92	0.8813102—1	66 : 90	0.8653014—1	48 : 68	0.8487323—1	61 : 90	0.8310873—1	61 : 94	0.8122019—1
35 : 46	0.8813102—1	55 : 75	0.8653014—1	36 : 51	0.8487323—1	63 : 93	0.8308576—1	48 : 74	0.8120095—1
54 : 71	0.8811355—1	44 : 60	0.8653014—1	67 : 95	0.8483512—1	42 : 62	0.8308576—1	59 : 91	0.8118106—1
73 : 96	0.8810517—1	33 : 45	0.8653014—1	55 : 78	0.8482681—1	65 : 96	0.8306422—1	35 : 54	0.8116742—1
76 : 100	0.8808136—1	63 : 86	0.8648420—1	43 : 61	0.8481387—1	44 : 65	0.8305393—1	46 : 71	0.8114995—1
57 : 75	0.8808136—1	52 : 71	0.8647450—1	62 : 88	0.8479090—1	67 : 99	0.8304396—1	57 : 88	0.8113922—1
38 : 50	0.8808136—1	41 : 56	0.8645959—1	31 : 44	0.8479090—1	46 : 68	0.8302489—1	55 : 85	0.8109438—1
60 : 79	0.8805242—1	71 : 97	0.8644866—1	50 : 71	0.8477117—1	48 : 71	0.8299829—1	44 : 68	0.8109438—1
41 : 54	0.8803901—1	60 : 82	0.8643374—1	69 : 98	0.8476230—1	50 : 74	0.8297383—1	33 : 51	0.8109437—1
63 : 83	0.8802624—1	30 : 41	0.8643374—1	57 : 81	0.8473899—1	52 : 77	0.8295726—1	64 : 99	0.8105448—1
44 : 58	0.8800247—1	49 : 67	0.8641213—1	38 : 54	0.8473898—1	54 : 80	0.8293038—1	53 : 82	0.8104620—1
66 : 87	0.8800246—1	68 : 93	0.8640260—1	64 : 91	0.8471386—1	56 : 83	0.8291099—1	42 : 65	0.8103359—1
69 : 91	0.8798077—1	57 : 78	0.8637803—1	45 : 64	0.8470325—1	58 : 86	0.8289205—1	62 : 96	0.8101205—1
47 : 62	0.8797062—1	38 : 52	0.8637803—1	52 : 74	0.8467716—1	60 : 89	0.8287613—1	31 : 48	0.8101205—1
72 : 95	0.8796089—1	65 : 89	0.8635234—1	59 : 84	0.8465727—1	62 : 92	0.8286039—1	51 : 79	0.8099431—1
75 : 99	0.8794261—1	46 : 63	0.8634173—1	66 : 98	0.8464160—1	31 : 46	0.8286039—1	60 : 93	0.8096684—1
50 : 66	0.8794261—1	73 : 100	0.8633229—1	33 : 87	0.8464160—1	64 : 95	0.8284564—1	40 : 62	0.8096683—1
53 : 70	0.8791779—1	54 : 74	0.8631621—1	40 : 57	0.8461851—1	66 : 98	0.8283178—1	49 : 76	0.8093825—1
56 : 74	0.8789563—1	62 : 85	0.8620728—1	47 : 67	0.8460231—1	33 : 49	0.8283178—1	58 : 90	0.8091855—1
59 : 78	0.8787574—1	70 : 96	0.8628268—1	54 : 77	0.8459031—1	35 : 52	0.8280647—1	38 : 59	0.8089316—1
62 : 82	0.8785778—1	35 : 48	0.8628268—1	61 : 87	0.8458105—1	37 : 55	0.8278390—1	47 : 73	0.8087750—1
31 : 41	0.8785778—1	43 : 59	0.8626165—1	68 : 97	0.8457372—1	39 : 58	0.8276366—1	56 : 87	0.8086987—1
65 : 86	0.8784149—1	51 : 70	0.8624722—1	49 : 70	0.8450981—1	41 : 61	0.8274541—1	54 : 84	0.8081145—1
68 : 90	0.8782664—1	59 : 81	0.8623670—1	70 : 100	0.8450980—1	43 : 64	0.8272885—1	45 : 70	0.8081145—1
34 : 45	0.8782664—1	67 : 92	0.8622870—1	63 : 90	0.8450980—1	45 : 67	0.8271377—1	36 : 56	0.8081145—1
71 : 94	0.8781304—1	72 : 99	0.8616973—1	56 : 80	0.8450980—1	47 : 70	0.8269999—1	63 : 98	0.8081144—1
74 : 98	0.8780056—1	64 : 88	0.8616973—1	42 : 60	0.8450980—1	49 : 73	0.8268732—1	61 : 95	0.8076062—1
37 : 49	0.8780056—1	56 : 77	0.8616973—1	35 : 50	0.8450980—1	51 : 76	0.8267566—1	52 : 81	0.8075183—1
40 : 53	0.8777841—1	48 : 66	0.8616973—1	65 : 93	0.8444305—1	53 : 79	0.8266488—1	43 : 67	0.8073937—1
43 : 57	0.8775936—1	40 : 55	0.8616973—1	58 : 83	0.8443499—1	55 : 82	0.8265488—1	34 : 53	0.8072030—1
46 : 61	0.8774280—1	32 : 44	0.8616973—1	51 : 73	0.8442473—1	57 : 85	0.8264560—1	59 : 92	0.8070642—1
49 : 65	0.8772827—1	60 : 95	0.8611255—1	44 : 63	0.8441122—1	59 : 88	0.8263693—1	50 : 78	0.8068754—1

TABLE OF RATIOS FOR GEAR TRAINS—Continued

N.	Log. N.	N.	Log. N.	N.	Log. N.	N.	Log. N.	N.	Log. N.
41 : 64	0.8066039—1	55 : 90	0.7861202—1	43 : 74	0.7642368—1	33 : 60	0.7403626—1	47 : 91	0.7130565—1
57 : 89	0.8064849—1	44 : 72	0.7861202—1	54 : 93	0.7639109—1	50 : 91	0.7399286—1	48 : 93	0.7127583—1
64 : 100	0.8061800—1	33 : 54	0.7861201—1	36 : 62	0.7639108—1	39 : 71	0.7398063—1	32 : 62	0.7127583—1
32 : 50	0.8061800—1	58 : 95	0.7857044—1	47 : 81	0.7636129—1	45 : 82	0.7393986—1	49 : 95	0.7124725—1
48 : 75	0.8061799—1	47 : 77	0.7856072—1	58 : 100	0.7634280—1	51 : 93	0.7390873—1	33 : 64	0.7123339—1
55 : 86	0.8058642—1	36 : 59	0.7854505—1	40 : 69	0.7632109—1	34 : 62	0.7390872—1	50 : 97	0.7121983—1
39 : 61	0.8057348—1	61 : 100	0.7853298—1	51 : 88	0.7630875—1	40 : 73	0.7387371—1	51 : 99	0.7119350—1
62 : 97	0.8056200—1	50 : 82	0.7851561—1	55 : 95	0.7626391—1	46 : 84	0.7384785—1	34 : 66	0.7119350—1
46 : 72	0.8054253—1	39 : 64	0.7848846—1	44 : 76	0.7626391—1	52 : 95	0.7382797—1	35 : 68	0.7115591—1
53 : 83	0.8051978—1	53 : 87	0.7847566—1	33 : 57	0.7626390—1	35 : 64	0.7378880—1	36 : 70	0.7112045—1
60 : 94	0.8050234—1	56 : 92	0.7844002—1	48 : 83	0.7621631—1	41 : 75	0.7377226—1	37 : 72	0.7108692—1
30 : 47	0.8050234—1	42 : 69	0.7844002—1	37 : 64	0.7620217—1	47 : 86	0.7375994—1	38 : 74	0.7105519—1
37 : 58	0.8047737—1	59 : 97	0.7840803—1	52 : 90	0.7617608—1	53 : 97	0.7375042—1	39 : 76	0.7102510—1
44 : 69	0.8046036—1	45 : 74	0.7839808—1	41 : 71	0.7615256—1	54 : 99	0.7367586—1	40 : 78	0.7099654—1
51 : 80	0.8044802—1	31 : 51	0.7837915—1	56 : 97	0.7614163—1	42 : 77	0.7367586—1	41 : 80	0.7096939—1
58 : 91	0.8043866—1	48 : 79	0.7836141—1	45 : 78	0.7611179—1	36 : 66	0.7367586—1	42 : 82	0.7094354—1
42 : 66	0.8037054—1	51 : 84	0.7832909—1	30 : 52	0.7611180—1	30 : 55	0.7367586—1	43 : 84	0.7091892—1
49 : 77	0.8037054—1	34 : 56	0.7832909—1	49 : 85	0.7607772—1	48 : 88	0.7367585—1	44 : 86	0.7089542—1
63 : 99	0.8037053—1	54 : 89	0.7830038—1	34 : 59	0.7606269—1	49 : 90	0.7359536—1	45 : 88	0.7087298—1
56 : 88	0.8037053—1	37 : 61	0.7828719—1	53 : 92	0.7604881—1	43 : 79	0.7358414—1	46 : 90	0.7085153—1
35 : 55	0.8037053—1	57 : 94	0.7827470—1	57 : 99	0.7602397—1	36 : 68	0.7356928—1	47 : 92	0.7083101—1
61 : 96	0.8030586—1	60 : 99	0.7825161—1	38 : 66	0.7602397—1	31 : 57	0.7354868—1	48 : 94	0.7081133—1
54 : 85	0.8029749—1	40 : 66	0.7825161—1	42 : 73	0.7599264—1	50 : 92	0.7351822—1	49 : 96	0.7079249—1
47 : 74	0.8028662—1	43 : 71	0.7822102—1	46 : 80	0.7596678—1	44 : 81	0.7349677—1	50 : 98	0.7077439—1
40 : 63	0.8027195—1	46 : 76	0.7819442—1	50 : 87	0.7594507—1	38 : 70	0.7346856—1	51 : 100	0.7075702—1
33 : 52	0.8025106—1	49 : 81	0.7817111—1	54 : 94	0.7592659—1	51 : 94	0.7344423—1	30 : 59	0.7062693—1
59 : 93	0.8023691—1	52 : 86	0.7815048—1	31 : 54	0.7589679—1	32 : 59	0.7342980—1	31 : 61	0.7060319—1
52 : 82	0.8021894—1	55 : 91	0.7813213—1	35 : 61	0.7587382—1	45 : 83	0.7341344—1	32 : 63	0.7058095—1
45 : 71	0.8019542—1	58 : 96	0.7811568—1	39 : 68	0.7585557—1	52 : 96	0.7337321—1	33 : 65	0.7056005—1
57 : 90	0.8016324—1	32 : 53	0.7808741—1	43 : 75	0.7584072—1	39 : 72	0.7337321—1	34 : 67	0.7054041—1
38 : 60	0.8016323—1	35 : 58	0.7806400—1	47 : 82	0.7582840—1	46 : 85	0.7333380—1	35 : 69	0.7052180—1
50 : 79	0.8013429—1	38 : 63	0.7804431—1	51 : 89	0.7581802—1	33 : 61	0.7331841—1	36 : 71	0.7050442—1
62 : 98	0.8011656—1	41 : 68	0.7802750—1	55 : 96	0.7580915—1	53 : 98	0.7330498—1	37 : 73	0.7048788—1
31 : 49	0.8011656—1	44 : 73	0.7801298—1	44 : 77	0.7569620—1	40 : 71	0.7328283—1	38 : 75	0.7047223—1
43 : 68	0.8009596—1	47 : 78	0.7800033—1	40 : 70	0.7569620—1	47 : 87	0.7325786—1	39 : 77	0.7045739—1
55 : 87	0.8008434—1	50 : 83	0.7798919—1	36 : 63	0.7569620—1	54 : 100	0.7323938—1	40 : 79	0.7044329—1
60 : 95	0.8004277—1	53 : 88	0.7797932—1	32 : 56	0.7569620—1	34 : 63	0.7321384—1	41 : 81	0.7042989—1
48 : 76	0.8004276—1	56 : 93	0.7797051—1	56 : 98	0.7569619—1	41 : 76	0.7319703—1	42 : 83	0.7041712—1
36 : 57	0.8004276—1	59 : 98	0.7796259—1	52 : 91	0.7569619—1	48 : 89	0.7318512—1	43 : 85	0.7040496—1
53 : 84	0.7999966—1	60 : 100	0.7781513—1	48 : 84	0.7569619—1	49 : 91	0.7311547—1	44 : 87	0.7039334—1
41 : 65	0.7998705—1	57 : 95	0.7781513—1	57 : 100	0.7558749—1	42 : 78	0.7311547—1	45 : 89	0.7038225—1
58 : 92	0.7996402—1	54 : 90	0.7781513—1	53 : 93	0.7557930—1	35 : 65	0.7311546—1	46 : 91	0.7037164—1
46 : 73	0.7994349—1	51 : 85	0.7781513—1	49 : 86	0.7550876—1	50 : 93	0.7304871—1	47 : 93	0.7036150—1
63 : 100	0.7993405—1	30 : 50	0.7781513—1	45 : 79	0.7555854—1	43 : 80	0.7303785—1	48 : 95	0.7035176—1
51 : 81	0.7990852—1	42 : 70	0.7781513—1	41 : 72	0.7554514—1	36 : 67	0.7302277—1	49 : 97	0.7034244—1
34 : 54	0.7990851—1	48 : 80	0.7781512—1	37 : 65	0.7552843—1	51 : 95	0.7298466—1	50 : 99	0.7033348—1
56 : 89	0.7987980—1	45 : 75	0.7781512—1	33 : 58	0.7550850—1	44 : 82	0.7296388—1	50 : 100	0.6989700—1
39 : 62	0.7986729—1	39 : 65	0.7781512—1	54 : 95	0.7546702—1	37 : 69	0.7293526—1	49 : 98	0.6989700—1
61 : 97	0.7985581—1	36 : 60	0.7781512—1	50 : 88	0.7544873—1	52 : 97	0.7292316—1	48 : 96	0.6989700—1
44 : 70	0.7983547—1	33 : 55	0.7781512—1	46 : 81	0.7542728—1	30 : 56	0.7289333—1	47 : 94	0.6989700—1
49 : 78	0.7981015—1	58 : 97	0.7766563—1	42 : 74	0.7540176—1	45 : 84	0.7289332—1	46 : 92	0.6989700—1
54 : 86	0.7978953—1	55 : 92	0.7765749—1	38 : 67	0.7537088—1	53 : 99	0.7286407—1	45 : 90	0.6989700—1
59 : 94	0.7977241—1	52 : 87	0.7764840—1	55 : 97	0.7535910—1	38 : 71	0.7285253—1	44 : 88	0.6989700—1
32 : 51	0.7975798—1	49 : 82	0.7763822—1	51 : 90	0.7533277—1	46 : 86	0.7282593—1	43 : 86	0.6989700—1
37 : 59	0.7973497—1	46 : 77	0.7762671—1	34 : 60	0.7533276—1	31 : 58	0.7279373—1	42 : 84	0.6989700—1
42 : 67	0.7971745—1	43 : 72	0.7761360—1	47 : 83	0.7530198—1	39 : 73	0.7277417—1	41 : 82	0.6989700—1
47 : 75	0.7970366—1	40 : 67	0.7759852—1	30 : 53	0.7528454—1	47 : 88	0.7276152—1	40 : 80	0.6989700—1
52 : 83	0.7969252—1	37 : 62	0.7758100—1	43 : 76	0.7526549—1	48 : 90	0.7269987—1	39 : 78	0.6989700—1
57 : 91	0.7968335—1	34 : 57	0.7756040—1	56 : 99	0.7525528—1	40 : 75	0.7269987—1	38 : 76	0.6989700—1
62 : 99	0.7967565—1	31 : 52	0.7753584—1	52 : 92	0.7522155—1	32 : 60	0.7269987—1	37 : 74	0.6989700—1
60 : 96	0.7958801—1	59 : 99	0.7752168—1	39 : 69	0.7522153—1	49 : 92	0.7264083—1	36 : 72	0.6989700—1
30 : 48	0.7958801—1	56 : 94	0.7750601—1	48 : 85	0.7518223—1	41 : 77	0.7262932—1	35 : 70	0.6989700—1
55 : 88	0.7958800—1	53 : 89	0.7748859—1	35 : 62	0.7516763—1	33 : 62	0.7261222—1	34 : 68	0.6989700—1
50 : 80	0.7958800—1	50 : 84	0.7746907—1	44 : 78	0.7513581—1	50 : 94	0.7258421—1	33 : 66	0.6989700—1
45 : 72	0.7958800—1	47 : 79	0.7744708—1	53 : 94	0.7511480—1	42 : 79	0.7256222—1	32 : 64	0.6989700—1
40 : 64	0.7958800—1	44 : 74	0.7742210—1	31 : 55	0.7509990—1	51 : 96	0.7252990—1	31 : 62	0.6989700—1
35 : 56	0.7958800—1	41 : 69	0.7739348—1	40 : 71	0.7508017—1	34 : 64	0.7252989—1	30 : 60	0.6989700—1
58 : 33	0.7949451—1	57 : 96	0.7736037—1	49 : 87	0.7506768—1	43 : 81	0.7249835—1	49 : 99	0.6945609—1
53 : 85	0.7948570—1	38 : 64	0.7736036—1	54 : 96	0.7501226—1	52 : 98	0.7247772—1	48 : 97	0.6944695—1
48 : 77	0.7947505—1	54 : 91	0.7733524—1	45 : 80	0.7501225—1	35 : 66	0.7245241—1	47 : 95	0.6943743—1
43 : 69	0.7946194—1	35 : 59	0.7732160—1	36 : 64	0.7501225—1	44 : 83	0.7243746—1	46 : 93	0.6942749—1
38 : 61	0.7944538—1	51 : 86	0.7730717—1	41 : 73	0.7494610—1	53 : 100	0.7242759—1	45 : 91	0.6941711—1
33 : 53	0.7942380—1	48 : 81	0.7727562—1	50 : 89	0.7495800—1	45 : 85	0.7237936—1	44 : 89	0.6940627—1
61 : 98	0.7941037—1	32 : 54	0.7727562—1	32 : 57	0.7492751—1	36 : 68	0.7237936—1	43 : 87	0.6939492—1
56 : 90	0.7939455—1	45 : 76	0.7723989—1	55 : 98	0.7491366—1	46 : 87	0.7232385—1	42 : 85	0.6938304—1
51 : 82	0.7937563—1	58 : 98	0.7722019—1	46 : 82	0.7489439—1	37 : 70	0.7231037—1	41 : 83	0.6937058—1
46 : 74	0.7935261—1	42 : 71	0.7719910—1	37 : 66	0.7486578—1	47 : 89	0.7227079—1	40 : 81	0.6935750—1
41 : 66	0.7932400—1	55 : 93	0.7718798—1	51 : 91	0.7485288—1	38 : 72	0.7224511—1	39 : 79	0.6934375—1
59 : 95	0.7931284—1	39 : 66	0.7715207—1	56 : 100	0.7481880—1	48 : 91	0.7221998—1	38 : 77	0.6932929—1
54 : 87	0.7928745—1	52 : 88	0.7715206—1	42 : 75	0.7481880—1	39 : 74	0.7218329—1	37 : 75	0.6931404—1
36 : 58	0.7928745—1	49 : 83	0.7711180—1	47 : 84	0.7478186—1	49 : 93	0.7217132—1	36 : 73	0.6929796—1
49 : 79	0.7925690—1	36 : 61	0.7709727—1	33 : 59	0.7476619—1	50 : 95	0.7212464—1	25 : 71	0.6928097—1
62 : 100	0.7923917—1	59 : 100	0.7708520—1	52 : 93	0.7475204—1	40 : 76	0.7212464—1	34 : 69	0.6926298—1
31 : 50	0.7923917—1	46 : 78	0.7706632—1	38 : 68	0.7472747—1	30 : 57	0.7212464—1	33 : 67	0.6924391—1
44 : 71	0.7921944—1	56 : 95	0.7704644—1	43 : 77	0.7469778—1	51 : 97	0.7207985—1	32 : 65	0.6922366—1
57 : 92	0.7920871—1	33 : 56	0.7703259—1	48 : 86	0.7467427—1	41 : 78	0.7206893—1	31 : 63	0.6920212—1
52 : 84	0.7917240—1	43 : 73	0.7701436—1	53 : 95	0.7465523—1	31 : 59	0.7205097—1	30 : 61	0.6917915—1
39 : 63	0.7917241—1	53 : 90	0.7700334—1	34 : 61	0.7461491—1	52 : 99	0.7203681—1	49 : 100	0.6901961—1
60 : 97	0.7913796—1	50 : 85	0.7695511—1	39 : 70	0.7459666—1	42 : 80	0.7201593—1	48 : 98	0.6900151—1
47 : 76	0.7912843—1	40 : 68	0.7695511—1	44 : 79	0.7458256—1	32 : 61	0.7198202—1	47 : 96	0.6898267—1
34 : 55	0.7911162—1	36 : 51	0.7695511—1	49 : 88	0.7457134—1	43 : 82	0.7196546—1	46 : 94	0.6896299—1
55 : 89	0.7909727—1	57 : 97	0.7691032—1	54 : 97	0.7456221—1	44 : 84	0.7191734—1	45 : 92	0.6894247—1
42 : 68	0.7907404—1	47 : 80	0.7690079—1	55 : 99	0.7447275—1	33 : 63	0.7191734—1	44 : 90	0.6892102—1
50 : 81	0.7904850—1	37 : 63	0.7688612—1	50 : 90	0.7447275—1	45 : 86	0.7187140—1	43 : 88	0.6889858—1
58 : 94	0.7903001—1	54 : 92	0.7686060—1	45 : 81	0.7447275—1	34 : 65	0.7185655—1	42 : 86	0.6887508—1
37 : 60	0.7900504—1	44 : 75	0.7683914—1	40 : 72	0.7447275—1	46 : 88	0.7182751—1	41 : 84	0.6885046—1
45 : 73	0.7898896—1	51 : 87	0.7680509—1	35 : 63	0.7447275—1	35 : 67	0.7179932—1	40 : 82	0.6882461—1
53 : 86	0.7897774—1	34 : 58	0.7680509—1	30 : 54	0.7447275—1	47 : 90	0.7178554—1	39 : 80	0.6879476—1
61 : 99	0.7896946—1	58 : 99	0.7677928—1	51 : 92	0.7437824—1	36 : 69	0.7174534—1	38 : 78	0.6876890—1
32 : 52	0.7891467—1	41 : 70	0.7676859—1	46 : 83	0.7436797—1	48 : 92	0.7174534—1	37 : 76	0.6873881—1
56 : 91	0.7891466—1	48 : 82	0.7674273—1	41 : 74	0.7435322—1	49 : 94	0.7170682—1	36 : 74	0.6870708—1
48 : 78	0.7891466—1	55 : 94	0.7672348—1	36 : 65	0.7433891—1	37 : 71	0.7169434—1	35 : 72	0.6867355—1
40 : 65	0.7891466—1	31 : 53	0.7670858—1	31 : 56	0.7431737—1	50 : 96	0.7166988—1	34 : 70	0.6863809—1
59 : 96	0.7885808—1	38 : 65	0.7668702—1	52 : 94	0.7428754—1	38 : 73	0.7164607—1	33 : 68	0.6860050—1
51 : 83	0.7884921—1	45 : 77	0.7667218—1	47 : 85	0.7426790—1	51 : 98	0.7163441—1	32 : 66	0.6856061—1
43 : 70	0.7883705—1	52 : 89	0.7666133—1	42 : 76	0.7424357—1	52 : 100	0.7160033—1	48 : 99	0.6856060—1
35 : 57	0.7881931—1	56 : 96	0.7659168—1	37 : 67	0.7421269—1	39 : 75	0.7160033—1	47 : 97	0.6853262—1
54 : 88	0.7879111—1	49 : 84	0.7659168—1	53 : 96	0.7420047—1	40 : 77	0.7155693—1	31 : 64	0.6851817—1
46 : 75	0.7876965—1	42 : 72	0.7659168—1	32 : 58	0.7417220—1	41 : 79	0.7151568—1	46 : 95	0.6850342—1
57 : 93	0.7873920—1	35 : 60	0.7659167—1	48 : 87	0.7417219—1	42 : 81	0.7147643—1	45 : 93	0.6847296—1
38 : 62	0.7873919—1	53 : 91	0.7652345—1	43 : 78	0.7413739—1	43 : 83	0.7143904—1	30 : 62	0.6847296—1
49 : 80	0.7871061—1	46 : 79	0.7651307—1	54 : 98	0.7411677—1	44 : 85	0.7140338—1	44 : 91	0.6844113—1
60 : 98	0.7869252—1	39 : 67	0.7649898—1	38 : 69	0.7409345—1	30 : 58	0.7136933—1	43 : 89	0.6840785—1
30 : 49	0.7869252—1	32 : 55	0.7647873—1	49 : 89	0.7408061—1	45 : 87	0.7130932—1	42 : 87	0.6837300—1
41 : 67	0.7867091—1	57 : 98	0.7646488—1	55 : 100	0.7403627—1	46 : 89	0.7133678—1	41 : 85	0.6833650—1
52 : 85	0.7865844—1	50 : 86	0.7644715—1	44 : 80	0.7403627—1	31 : 60	0.7132104—1	40 : 83	0.6829819—1

TABLE OF RATIOS FOR GEAR TRAINS—Continued

N.	Log. N.	N.	Log. N.	N.	Log. N.	N.	Log. N.	N.	Log. N.
39 : 81	0.6825796—1	32 : 70	0.6600520—1	31 : 72	0.6340292—1	37 : 92	0.6044139—1	33 : 90	0.5642714—1
38 : 79	0.6821565—1	37 : 81	0.6597167—1	34 : 79	0.6338518—1	39 : 97	0.6042929—1	30 : 82	0.5633074—1
37 : 77	0.6817110—1	42 : 92	0.6594615—1	37 : 86	0.6337032—1	40 : 100	0.6020600—1	34 : 93	0.5629960—1
48 : 100	0.6812412—1	31 : 68	0.6588528—1	40 : 93	0.6335771—1	38 : 95	0.6020600—1	31 : 85	0.5619428—1
36 : 75	0.6812412—1	36 : 79	0.6586754—1	43 : 100	0.6334685—1	36 : 90	0.6020600—1	35 : 96	0.5617968—1
47 : 98	0.6808718—1	41 : 90	0.6585414—1	42 : 98	0.6320232—1	34 : 85	0.6020600—1	36 : 99	0.5606673—1
35 : 73	0.6807451—1	30 : 66	0.6575774—1	39 : 91	0.6320232—1	32 : 80	0.6020600—1	32 : 88	0.5606673—1
46 : 96	0.6804866—1	45 : 99	0.6575773—1	36 : 84	0.6320232—1	30 : 75	0.6020600—1	33 : 91	0.5594725—1
34 : 71	0.6802206—1	40 : 88	0.6575773—1	33 : 77	0.6320232—1	39 : 98	0.5998385—1	34 : 94	0.5581570—1
45 : 94	0.6800846—1	35 : 77	0.6575773—1	30 : 70	0.6320233—1	37 : 93	0.5997188—1	30 : 83	0.5580432—1
44 : 92	0.6796649—1	44 : 97	0.6566810—1	41 : 96	0.6305127—1	35 : 88	0.5995853—1	35 : 97	0.5572963—1
33 : 69	0.6796648—1	39 : 86	0.6565661—1	38 : 89	0.6303936—1	33 : 83	0.5994358—1	31 : 86	0.5568632—1
43 : 90	0.6792260—1	34 : 75	0.6564176—1	35 : 82	0.6302541—1	31 : 78	0.5992671—1	36 : 100	0.5563025—1
32 : 67	0.6790752—1	43 : 95	0.6557449—1	32 : 75	0.6300887—1	38 : 96	0.5975724—1	32 : 89	0.5557600—1
42 : 88	0.6787666—1	38 : 84	0.6555043—1	40 : 94	0.6289321—1	36 : 91	0.5972611—1	33 : 92	0.5547261—1
31 : 65	0.6784483—1	33 : 73	0.6551910—1	37 : 87	0.6286824—1	34 : 86	0.5969804—1	34 : 95	0.5537553—1
41 : 86	0.6782854—1	42 : 93	0.6547664—1	34 : 80	0.6283889—1	22 : 81	0.5966650—1	30 : 84	0.5528420—1
30 : 63	0.6777808—1	37 : 82	0.6543878—1	31 : 73	0.6280388—1	30 : 76	0.5963077—1	35 : 98	0.5528419—1
40 : 84	0.6777807—1	22 : 71	0.6538917—1	42 : 99	0.6276141—1	39 : 99	0.5954294—1	31 : 87	0.5518424—1
39 : 82	0.6772507—1	41 : 91	0.6537425—1	39 : 92	0.6272768—1	37 : 94	0.5950758—1	32 : 90	0.5509075—1
38 : 80	0.6766936—1	45 : 100	0.6532125—1	36 : 85	0.6268836—1	35 : 89	0.5946780—1	33 : 93	0.5500310—1
47 : 99	0.6764627—1	36 : 80	0.6532125—1	33 : 78	0.6264193—1	33 : 84	0.5942346—1	34 : 96	0.5192077—1
37 : 78	0.6761071—1	40 : 89	0.6526700—1	41 : 97	0.6260122—1	31 : 79	0.5937946—1	35 : 99	0.5484328—1
46 : 97	0.6759861—1	31 : 69	0.6525126—1	30 : 71	0.6258630—1	38 : 97	0.5930119—1	30 : 85	0.5477024—1
45 : 95	0.6754889—1	44 : 98	0.6522266—1	38 : 90	0.6255411—1	36 : 92	0.5925247—1	31 : 88	0.5468790—1
36 : 76	0.6754889—1	35 : 78	0.6519734—1	35 : 83	0.6249893—1	34 : 87	0.5919596—1	32 : 91	0.5461086—1
44 : 93	0.6749698—1	39 : 87	0.6515453—1	40 : 95	0.6243364—1	32 : 82	0.5913361—1	33 : 94	0.5453860—1
35 : 74	0.6748363—1	43 : 96	0.6511973—1	32 : 76	0.6243364—1	39 : 100	0.5910646—1	34 : 97	0.5447072—1
43 : 91	0.6744271—1	30 : 67	0.6510465—1	37 : 88	0.6237190—1	30 : 77	0.5906306—1	35 : 100	0.5440680—1
34 : 72	0.6741464—1	34 : 76	0.6506653—1	42 : 100	0.6232493—1	37 : 95	0.5904781—1	30 : 86	0.5426228—1
42 : 89	0.6738593—1	38 : 85	0.6503647—1	34 : 81	0.6229939—1	35 : 90	0.5898255—1	31 : 89	0.5419717—1
33 : 70	0.6734159—1	42 : 94	0.6501214—1	39 : 93	0.6225817—1	33 : 85	0.5890950—1	32 : 92	0.5413622—1
41 : 87	0.6732646—1	33 : 74	0.6492822—1	31 : 74	0.6221300—1	38 : 98	0.5885575—1	33 : 95	0.5407903—1
40 : 85	0.6726411—1	37 : 83	0.6491236—1	36 : 86	0.6218040—1	31 : 80	0.5882717—1	34 : 98	0.5402528—1
32 : 68	0.6726411—1	41 : 92	0.6489961—1	41 : 98	0.6215578—1	36 : 93	0.5878196—1	30 : 87	0.5376020—1
47 : 100	0.6720979—1	44 : 99	0.6478175—1	33 : 79	0.6208868—1	34 : 88	0.5869962—1	31 : 90	0.5371192—1
39 : 83	0.6719865—1	40 : 90	0.6478175—1	38 : 91	0.6207422—1	32 : 83	0.5860719—1	32 : 93	0.5366671—1
31 : 66	0.6718178—1	36 : 81	0.6478175—1	40 : 96	0.6197888—1	37 : 96	0.5859305—1	33 : 96	0.5362427—1
46 : 98	0.6715317—1	32 : 72	0.6478175—1	30 : 72	0.6197888—1	30 : 78	0.5850267—1	34 : 99	0.5358437—1
38 : 81	0.6712986—1	43 : 97	0.6466968—1	25 : 84	0.6197887—1	35 : 91	0.5850266—1	30 : 88	0.5226386—1
45 : 96	0.6709413—1	39 : 88	0.6465819—1	37 : 89	0.6188117—1	38 : 99	0.5841484—1	31 : 91	0.5323203—1
30 : 64	0.6709413—1	35 : 79	0.6464409—1	32 : 77	0.6186593—1	33 : 86	0.5870154—1	32 : 94	0.5320221—1
37 : 79	0.6705746—1	31 : 70	0.6462637—1	39 : 94	0.6179367—1	36 : 94	0.5831746—1	33 : 97	0.5317422—1
44 : 94	0.6703248—1	42 : 95	0.6455257—1	34 : 82	0.6176650—1	31 : 81	0.5828767—1	34 : 100	0.5314789—1
36 : 77	0.6698118—1	38 : 86	0.6452851—1	41 : 99	0.6171487—1	34 : 89	0.5820889—1	30 : 89	0.5277313—1
43 : 92	0.6696807—1	34 : 77	0.6449882—1	26 : 87	0.6167832—1	37 : 97	0.5814300—1	31 : 92	0.5275739—1
42 : 90	0.6690068—1	30 : 68	0.6446124—1	31 : 75	0.6163004—1	32 : 84	0.5808707—1	32 : 95	0.5274264—1
35 : 75	0.6690067—1	41 : 93	0.6443010—1	38 : 92	0.6159958—1	35 : 92	0.5802802—1	33 : 98	0.5272878—1
41 : 88	0.6683012—1	37 : 84	0.6439224—1	33 : 80	0.6154239—1	38 : 100	0.5797836—1	32 : 96	0.5228788—1
34 : 73	0.6681560—1	44 : 100	0.6434527—1	40 : 97	0.6152883—1	30 : 79	0.5794942—1	31 : 93	0.5228788—1
40 : 86	0.6675615—1	33 : 75	0.6434526—1	35 : 85	0.6146491—1	33 : 87	0.5789946—1	30 : 90	0.5228788—1
33 : 71	0.6672556—1	40 : 91	0.6430186—1	37 : 90	0.6139592—1	36 : 95	0.5785789—1	33 : 99	0.5228787—1
46 : 99	0.6671226—1	36 : 82	0.6424886—1	30 : 73	0.6137984—1	31 : 82	0.5775478—1	33 : 100	0.5185139—1
39 : 84	0.6667853—1	43 : 98	0.6422424—1	39 : 95	0.6133410—1	34 : 90	0.5772364—1	32 : 97	0.5183783—1
45 : 97	0.6664408—1	32 : 73	0.6418271—1	32 : 78	0.6130554—1	37 : 98	0.5769756—1	31 : 94	0.5182338—1
32 : 69	0.6663009—1	39 : 89	0.6416746—1	41 : 100	0.6127839—1	32 : 85	0.5757311—1	30 : 91	0.5180799—1
38 : 82	0.6659697—1	42 : 96	0.6409781—1	24 : 83	0.6124008—1	35 : 93	0.5755851—1	32 : 98	0.5139239—1
44 : 95	0.6657291—1	35 : 80	0.6409780—1	36 : 88	0.6118198—1	36 : 96	0.5740313—1	31 : 95	0.5136381—1
31 : 67	0.6652869—1	38 : 87	0.6402643—1	38 : 93	0.6113007—1	30 : 80	0.5740313—1	30 : 92	0.5133335—1
37 : 80	0.6651117—1	31 : 71	0.6401034—1	40 : 98	0.6108339—1	33 : 88	0.5740312—1	32 : 99	0.5095148—1
43 : 93	0.6649856—1	41 : 94	0.6396560—1	31 : 76	0.6105481—1	37 : 99	0.5725665—1	31 : 96	0.5090905—1
42 : 91	0.6642079—1	34 : 78	0.6393843—1	33 : 81	0.6100289—1	34 : 91	0.5724275—1	30 : 93	0.5086384—1
36 : 78	0.6642079—1	37 : 85	0.6387828—1	35 : 86	0.6095695—1	31 : 83	0.5722836—1	32 : 100	0.5051500—1
30 : 65	0.6642079—1	40 : 92	0.6382722—1	37 : 91	0.6091603—1	35 : 94	0.5709401—1	31 : 97	0.5045900—1
41 : 89	0.6633939—1	30 : 69	0.6382722—1	39 : 96	0.6087934—1	32 : 86	0.5706515—1	30 : 94	0.5039934—1
35 : 76	0.6632544—1	43 : 99	0.6378333—1	30 : 74	0.6078896—1	36 : 97	0.5695308—1	31 : 98	0.5001356—1
46 : 100	0.6627578—1	33 : 76	0.6377003—1	32 : 79	0.6075229—1	33 : 89	0.5691239—1	30 : 95	0.4993977—1
40 : 87	0.6625407—1	36 : 83	0.6372244—1	34 : 84	0.6071996—1	30 : 81	0.5686363—1	31 : 99	0.4957265—1
34 : 74	0.6622472—1	39 : 90	0.6368221—1	36 : 89	0.6069125—1	37 : 100	0.5682017—1	30 : 96	0.4948501—1
45 : 98	0.6619864—1	42 : 97	0.6364776—1	28 : 94	0.6066557—1	34 : 92	0.5676911—1	31 : 100	0.4913617—1
39 : 85	0.6616457—1	32 : 74	0.6359183—1	40 : 99	0.6064248—1	31 : 84	0.5670824—1	30 : 97	0.8903496—1
44 : 96	0.6611815—1	35 : 81	0.6355830—1	31 : 77	0.6048710—1	35 : 95	0.5663444—1	30 : 98	0.4858952—1
33 : 72	0.6611814—1	38 : 88	0.6353009—1	33 : 82	0.6047000—1	32 : 87	0.5656307—1	30 : 99	0.4814861—1
38 : 83	0.6607055—1	41 : 95	0.6350603—1	35 : 87	0.6045487—1	36 : 98	0.5650764—1	30 : 100	0.4771213—1
43 : 94	0.6603406—1								

A Soft-Metal Bushing Mold

A mold for casting soft-metal bushings is illustrated in Fig. 1. The mold disassembled is shown in Fig. 2. The base, shown at *A*, has a hole in it to receive the end of the mandrel *B*. A recess is also turned in it to receive the projections turned on the lower ends of the parts *C* and *D*. Four dowels in the mold parts keep them in correct alignment. The top *E* has a hole for the upper end of the mandrel and a shoulder turned on its under side to fit the hole of the mold. The melted metal is poured through a small hole drilled close to the center hole. Various combinations of center mandrels and mold parts may be used in the same base to form different sizes of bushings. Some of the bushings made in this mold are shown at *F*, *G* and *H*. The mold is used in the shop of F. W. Lindgren Co., Rockford, Ill., with satisfactory results.

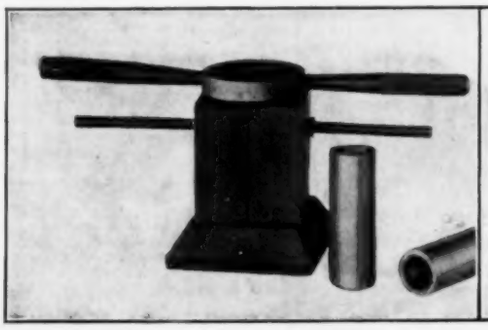


FIG. 1. A BUSHING MOLD

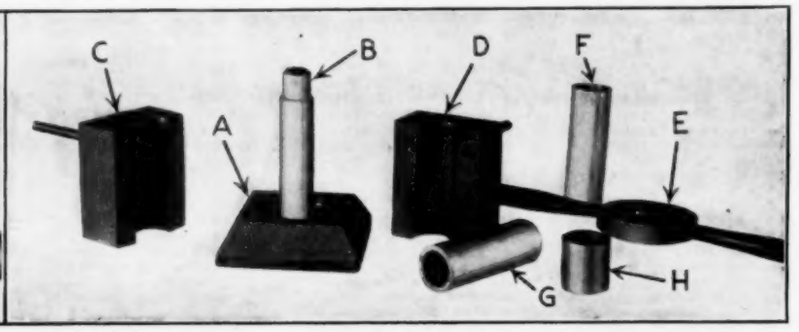


FIG. 2. THE MOLD DISASSEMBLED TO SHOW CONSTRUCTION

Avoiding Redesign of Standard Machine Parts

EDITORIAL CORRESPONDENCE

SYNOPSIS—A problem in many drawing rooms is the prevention of duplication, or practical duplication, of machine parts as new designs are developed. The S. A. Woods Machine Co. has a simple method of designating the sizes of several classes of parts by a system of symbols, which permits the filing of standard prints in a form for easy reference.

So much has been said and written concerning the waste of redesigning machine parts in new designs instead of using parts already being manufactured that little needs to be added by way of emphasis. The frittering away of time and effort in designing a new pulley or gear or screw or shaft, which is a duplicate or practical duplicate of one already in use in some machine manufactured by the firm, is now generally recognized. But a mere recognition of this waste does not bring a remedy. From time to time we have shown numerous methods in the *American Machinist* whereby an attempt was made to standardize and file the drawings of parts, so that when a new machine was under development as many as possible of these older pieces could be used in its design. The trouble with many of these systems is their complexity. They require some sort of special numbering in list form and a corresponding filing by number to individualize the various parts. This means that a designer must spend more or less time in searching through the standard file, hoping to find something that closely resembles the part he wishes to use. In contrast to some of these methods is the one in use in the drawing room of the S. A. Woods Machine Co., Boston, Mass.

The idea behind this system is to symbolize the parts according to size. Thus when the parts are filed according to symbol sequence they are in a series, dependent upon the size of the pieces. This at once permits of a short, easy search when a designer is trying to find a stock part that closely approximates the one he wishes to use.

The simplicity of the system is well shown by the drawings illustrating this article. For some kinds of parts a standard form is printed on a piece of 5x8-in. bond paper, on which the necessary dimensions are filled in and the essential information noted. This becomes the drawing of the part and prints from it enter the working files of standard parts. An example of this is Fig. 1, which reproduces the standard form for gears.

Figs. 2, 3 and 4 reproduce three standard reference gear drawings or designs. It will be noticed that each is made on one of the standard printed forms of Fig. 1.

It is worth while to observe the ease with which details of design can be added to the original sketch on the form before turning to the method of numbering or symbolization. In Fig. 2 a $3\frac{3}{4}$x$\frac{7}{8}$-in. boss has been added; in Fig. 3, one $2\frac{1}{4}$x$\frac{1}{2}$-in., and in Fig. 4 the necessary changes have been made to show that the gear is webbed and has a setscrew hole.

In each case a form in the corner tabulates the important dimensions, which include pitch, pitch diameter, number of teeth, face width, whether cut or cast, material, diameter of bore, size of keyway, diameter of setscrew and the diameter to which the blank should be turned.

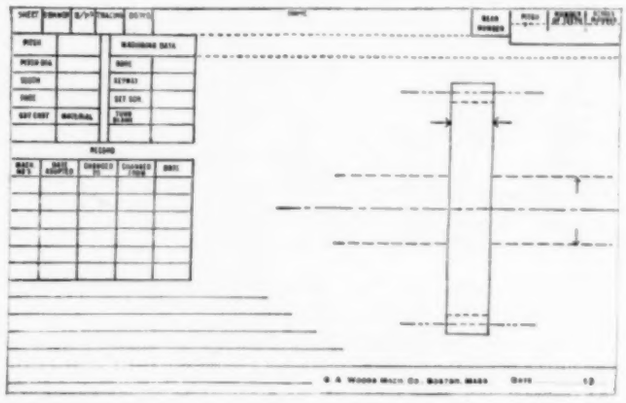


Fig. 1

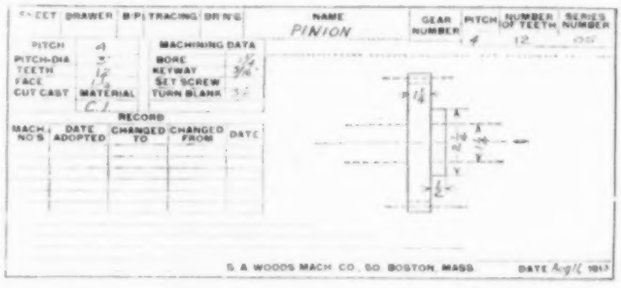


Fig. 3

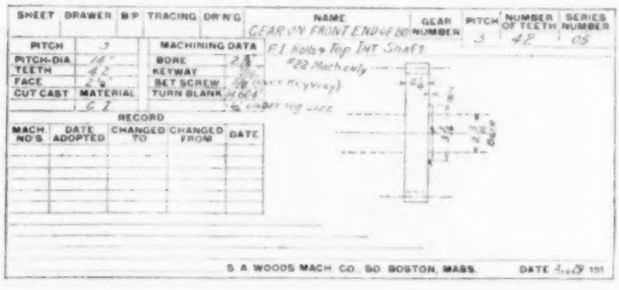


Fig. 2

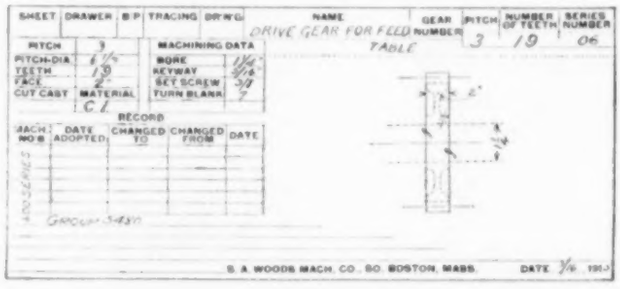


Fig. 4

FIGS. 1 TO 4. REFERENCE DRAWINGS FOR STANDARD GEARS—ORIGINALS 5x8 IN.

These are all the data that a designer needs to know in order to apply a stock gear to the mechanism upon which he is at work.

The system of numbering, or symbolization, hinges upon the pitch and number of teeth. For instance, in Fig. 2 the pitch of the gear is No. 3 and the number of teeth 42.

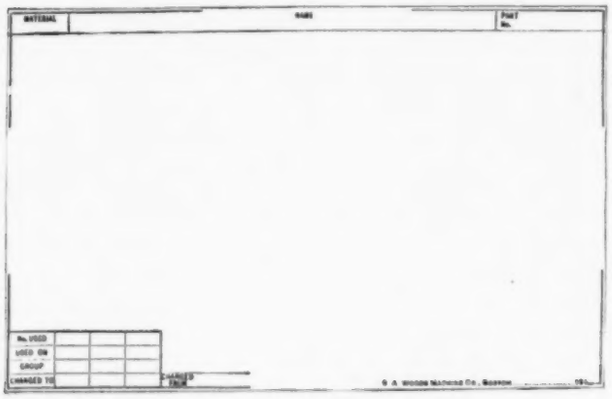


Fig. 5

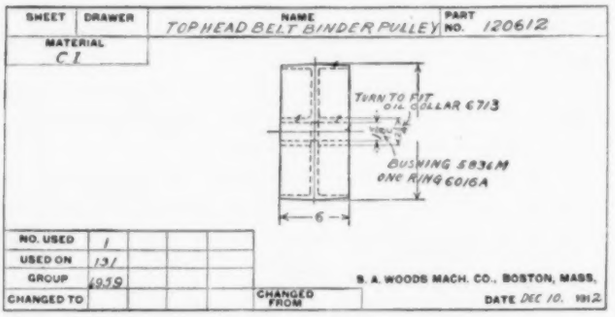


Fig. 6

Comment is unnecessary in regard to the type of drawings and dimensions, for these show for themselves. In

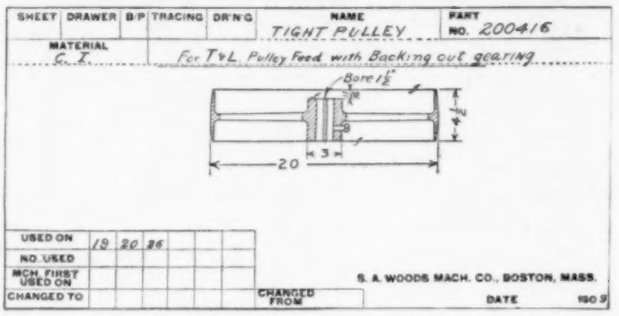


Fig. 7

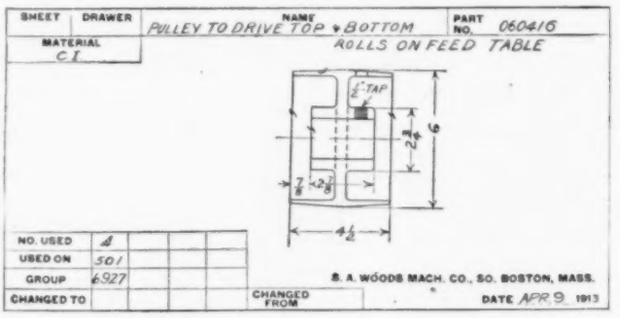


Fig. 8

FIGS. 5 TO 8. REFERENCE DRAWINGS FOR STANDARD PULLEYS

Thus the first two numbers of the symbol are 3-42. Similarly in the case of Fig. 3, the pitch is No. 4, the number of teeth 12 and the size-distinguishing part of the symbol 4-12. And again for Fig. 4 the pitch is No. 3, the number of teeth 19 and the size-designating part of the symbol 3-19.

The method of filing these drawings for standard reference is according to the first number, which designates the pitch, and then according to the second number, which designates the number of teeth. The ease with which a designer or draftsman can look up a gear approximating the size that he wishes to use is readily appreciated.

It is obvious that for many parts a standard form having an outline of the part cannot be used. This method works successfully for gears, but can hardly be applied to pulleys because of the wide variations in proportions and details. For such parts another standard form has been drawn, shown in Fig. 5. Its use in making the drawings for pulley standards is illustrated by Figs. 7 and 8 (although these were drawn on forms before the final revision represented by Fig. 5), which also are typical of the standard reference drawings for pulleys.

regard to data, but few are needed except the kind of material, which is indicated in the upper left-hand corner.

The symbolization scheme is based on dimensions, as in the case of gears. Here the first number is the diameter; the second, the width of the face. Thus in Fig. 6 the pulley is 12 in. in diameter with 6-in. face, and the first numbers of the symbol are 12-6. In case the pulley is less than 10 in. in diameter the first figure becomes 0, as shown by the symbol of Fig. 8. If a dimension is fractional, only the integer enters the symbol. For instance, if a pulley is 8½ in. in diameter, the first number of its symbol would be 08.

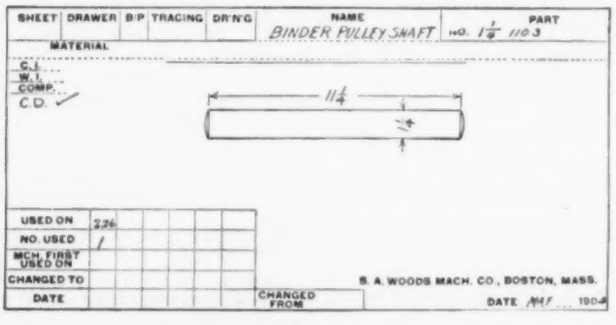


Fig. 9

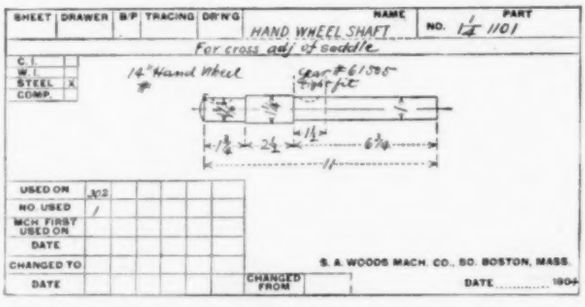


Fig. 10

FIGS. 9 AND 10. REFERENCE DRAWINGS FOR STANDARD SHAFTS—ORIGINALS 5x8 IN.

The other examples of these standard reference drawings are of shafts and screws, and are given in Figs. 9 to 14, the first three being shafts and the final three screws.

The blanks for the shafts differ from the one shown for pulleys, but the latter is used for screws. As the preparation of these drawings and their use are a part of the same system as that previously described, no comments are necessary except in regard to the method of numbering or symbolization. In the case of shafts the first number is the diameter and is expressed in fractions if the diameter of the shaft is fractional. In Fig. 9 the shaft is 1¼ in. in diameter, and the first number of the symbol is 1¼. The second number of the symbol is the length, which in the case of Fig. 11 is 11¼ in., giving the symbol number 11, for here fractions are disregarded.

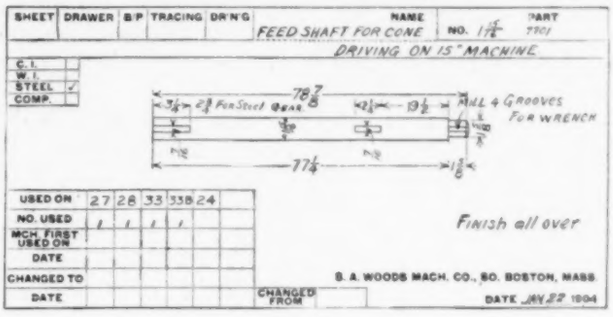


Fig. 11

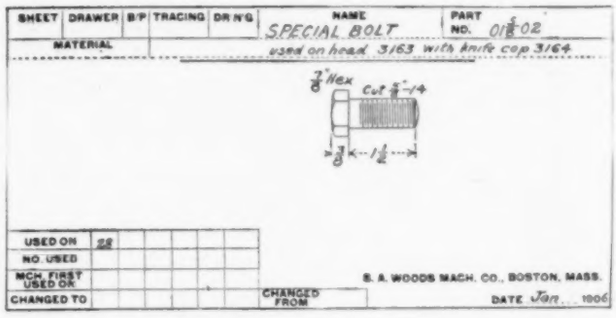


Fig. 12

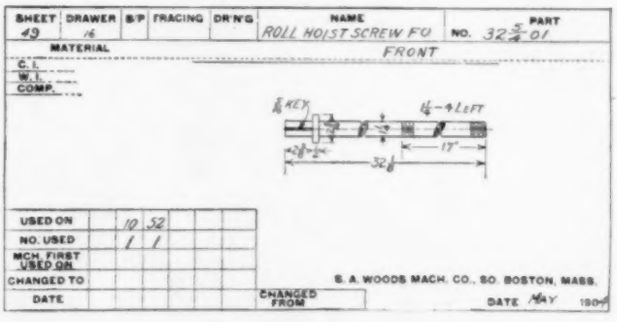


Fig. 13

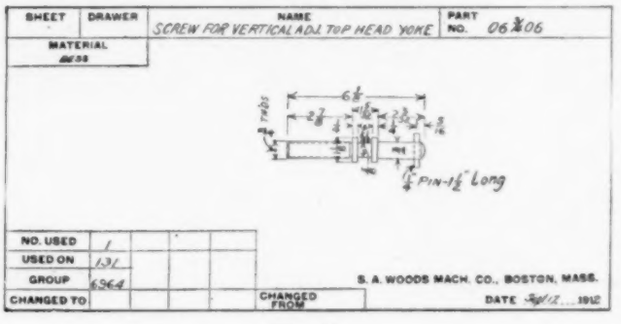


Fig. 14

FIGS. 11 TO 14. REFERENCE DRAWINGS FOR STANDARD SHAFTS AND SCREWS—ORIGINALS 5x8 IN.

The three prints are illustrative of three common types of machine shafts. In case a shaft is more than 99 in. long it is designated as 99 for length. In general machinery building the number of shafts over this length are few.

The method of numbering or symbolizing the screw drawings is based on the length under the head and the thread diameter. For instance, in Fig. 12 the length under the head is 1½ in., which means that in the symbol it is designated as 01, and the diameter being ⅝, the second number of the symbol becomes ⅝. The way this method is followed out is readily seen by consulting Figs. 13 and 14. In Fig. 13 a variation in the method of expressing the fractional diameter is seen, for the 1¼ in. becomes $^5/_4$ in the symbol.

This system of symbolizing and filing designs of standard parts has been followed for a number of years and during that time has stood the test of constant use. Its simplicity is one of its important features.

Helping the Standard-Price Man Get Off

By Frank C. Hudson

Of course honesty is the best policy. The books say so, the preachers preach it, and we know it is anyhow—but it sure keeps a fellow in the machine-tool business a-guessing these days to know just how to spell it and what it means after he does get it down right. There probably isn't anything really dishonest about charging a man double or triple price on a lathe, especially when he is going to use it to make ammunition at a correspondingly high price. But it's rather hard on the chap that has to have a lathe to make his regular product at the regular price. Of course he doesn't have to have the lathe, but his little business may go to pot from nonproductitis if he doesn't get it.

It's a big temptation to get all you can while the getting is good, especially if you've had a few lean years before, but if you plan to stay in business after the war is over, it's a mighty good plan to think twice before you give the melon an extra squeeze. Some are saying openly that they're going to get theirs now and then quit the game. But the fellow who buys the business may have some trouble in living down a past.

If, on the other hand, we bank on the saying that "virtue hath its own reward," just how is it going to pan out unless we help things along a bit? Where does the fellow get off who has been foolish (or wise) enough not to jump his price except to cover actual increased cost of labor and material? Is the buyer going to appreciate fair prices and delivery when promised, enough to stick to the maker who stuck to him, or is he going to forget all about this and buy machines from the chap who boosted prices and promised deliveries he knew he couldn't make?

There's a day of reckoning coming in the machine-tool field unless all signs fail and the goose bone has lost its cunning as a prognosticator. Buyers have it in their power to reward and to punish, both as to prices and to quality of work. And if they forget the builders who have resisted the temptation to skyrocket prices, who have refused bonuses in order to deliver all machines in turn as ordered and have otherwise passed up opportun-

ities for making wads of easy money, they deserve to be stung good and proper whenever anyone gets a chance.

The buyer is going to have his inning again some of these days, and the high and mighty seller will be traveling around after anything that sounds like an order, as of yore. And if the buyer doesn't administer several smart slaps on the wrist, I miss my guess again.

The machine-tool business has drifted into bad ways of late, in spots at least; ways that the second-hand clothing man keeps for dark days and real hayseeds. And, as usually seems to be the case, the reform must be forced on it from the outside. The buyers can do it, and if they know which side of their bread has the marmalade, they will do it when the time comes.

A Department of Manufactures

By G. A. Bisset

Just as the infant republic of farmers needed a Department of Agriculture, so does the adult manufacturing nation need a Department of Manufactures.

Such a department would take over the Bureau of Standards and add vastly thereto. The American Society of Testing Materials would no longer have any reason for existence. The Department of Manufactures would take over all the experimenting now being done by that society. Instead of having experiments carried on by a few scientists half-heartedly in idle moments, or rather in moments snatched from busy careers, the employees of this new department would devote their whole time to experimenting. In this way results would be not only much quicker, but much more reliable than anything now obtainable.

The main function of the department would be the study and test of manufactures, that is, manufactured products, in order that consumers might be fully informed. Instead of the farmer's being required to settle for himself from his insufficient facilities whether the "Deering" or the "McCormick" harvester is better, this thoroughly equipped department would tell him from the results of its tests, giving the relative values of the two machines.

The physician is too busy with his own important work to study out for himself which make of automobile best suits his requirements. Instead of being required to take some salesman's word for it, he should be able to learn from an impartial judge—the Department of Manufactures—which machine best meets his requirements.

The different departments of the government now make tests of materials required for their own uses. Instead of the results of these tests being published for the information of all, however, they are actually kept a close secret. This secrecy is observed in order to protect those manufacturers whose products do not show the best results. In fact the manufacturer whose product shows the best results can tell no one about it, as before he is informed of the result of the test, he must engage not to use the report for advertising purposes.

Such a policy, while it protects the manufacturers of inferior goods, seems far from altruistic. It would seem that a government "by the people" and "for the people" should operate for the greatest good of the greatest number. By publishing broadcast the results of the tests, many consumers would profit.

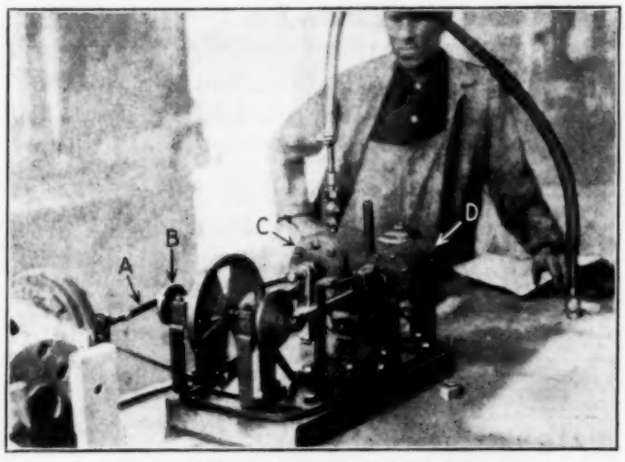
The Navy Department is constantly making tests of all kinds of materials. In the course of these tests facts come to light that are made use of to the great advantage of the service. In the test, for instance, of a number of different kinds of fire-extinguishers it was found that the difference between the best and the worst was simply inconceivable. The unsuspecting public, however, doubtless continues to buy the inefficient fire-extinguisher when one worth ten times as much could be obtained for the same money.

One of the functions of the new department would be to collect and disseminate all such information as that referred to above—the best fire-extinguisher; the best kind of red-lead paint, whether that made from the dry pigment or that from pigment ground in oil; the best anti-corrosive and anti-fouling paint for ships' bottoms; the best tool steels, etc. Included in this function would be the exposing of the exaggerated claims falsely made for various products, just as many patent medicines have recently been exposed by independent investigators.

Air Engine for Grinding Valves

By E. A. Thanton

Almost every railroad shop has some mechanical device for grinding air valves. I have been through a majority of the railroad shops of this country, but the device shown differs from anything I ever saw for the purpose. It is in the Queen & Crescent shops, Somerset, Ky., and was made by W. L. York, who has long been employed there. The grinding tools are practically the same as those used



AN ENGINE FOR GRINDING VALVES

in all other shops. The reciprocating movement needed is given by means of an air engine, the valve to be ground being bolted to angle irons on the same bench with the engine. The grinding tool is connected to the engine by means of a rod *A* fastened to the disk crank *B* on the flywheel shaft. The large cylinder *C* is the work cylinder and *D* is the slide valve. The work cylinder has a bore of 2½ in. and a stroke of 2⅜ in. The slide valve is 1⅞ in. wide and 2 1/16 in. long, with a stroke of ¾ in. The flywheel is 7 in. in diameter and the baseplate 10x18½ in. From the baseplate to the top of the work cylinder is 7½ in. Air is taken from the regular shop line, which carries an average pressure of 90 lb. The speed of the engine varies according to the pressure admitted to the cylinder, so that the proper grinding speed is easily obtained.

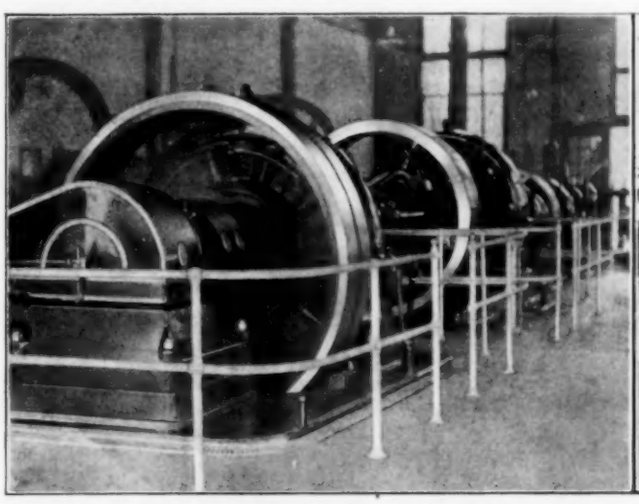
Practical Safeguards Used in a Railroad Shop

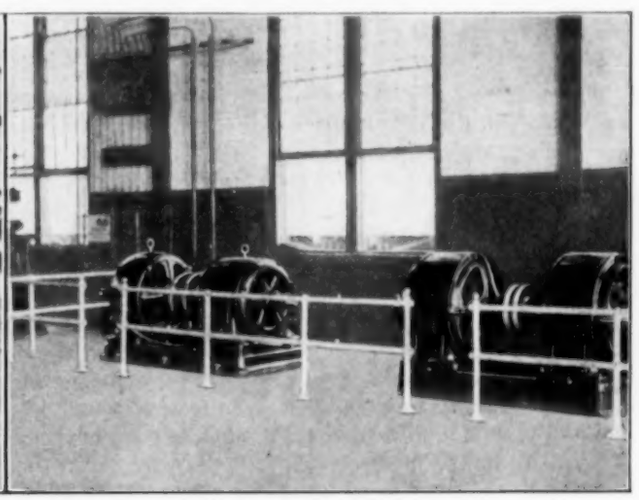
By Ethan Viall

SYNOPSIS—The safeguards shown here were made in the shop where they are used and may be applied under similar conditions in almost any shop. They are not only suggestive to railroad-shop men but to those in many other lines.

As a rule a railroad shop is a good place for a man to exercise his ingenuity, and many interesting mechanical devices are to be found in the average shop of this character. One reason is that it is much easier and quicker for a railroad man to make a thing from material at hand than to obtain a device ready to use through the regular channels that must be followed before he secures it. If he makes it, he is sure of it. If he requests it, he may get it and he may not. Then, too, when anything is made in a railroad shop and is a success, it generally brings quick recognition from those higher up—in praise at least, if nothing more.

In following out the popular slogan "Safety first!" the master mechanic of the Queen & Crescent R.R. shops at Somerset, Ky., has eliminated as far as possible the main danger points of the shops under his charge. In this he has been supported by the various department foremen and individual workmen. As as result, safeguards are to be seen everywhere and are constantly being added as the needs become known. All the safeguards in use were made from material already at hand. That some points have been overlooked is a foregone conclusion, but one can rest assured that the high spots of danger have long since been leveled, and only some of the more inconspicuous have been left, and these are being eliminated as fast as possible.





FIGS. 1 AND 2. PROTECTIVE RAILINGS AROUND ENGINES AND GENERATOR SETS IN THE POWER HOUSE

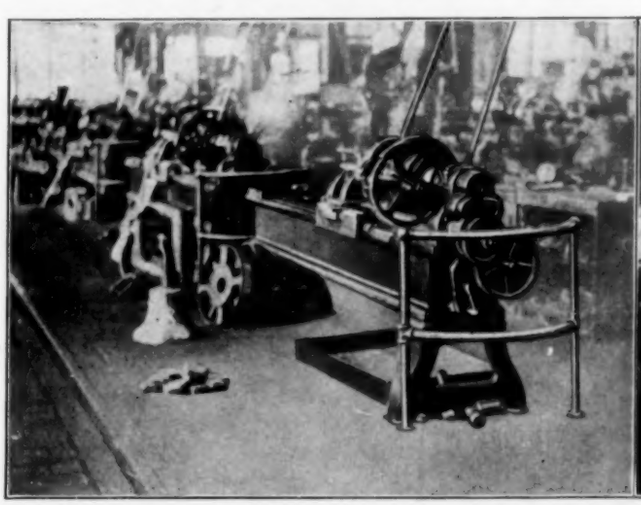


FIG. 3. RAILINGS AT HEAD END OF LATHES

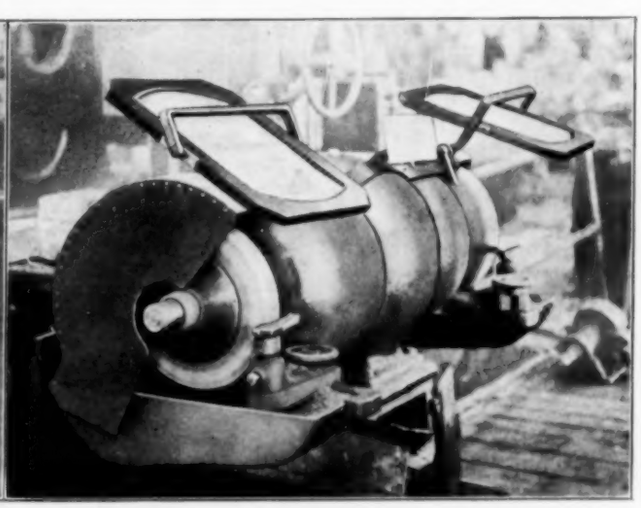


FIG. 4. EYE PROTECTORS FOR GRINDERS

Beginning with the power plant, with its brick walls, cement floors and plenty of light, one at once notices how the various moving parts are guarded, if possible, and how all the engines and generator sets are railed off. This is partly shown in Figs. 1 and 2. These railings

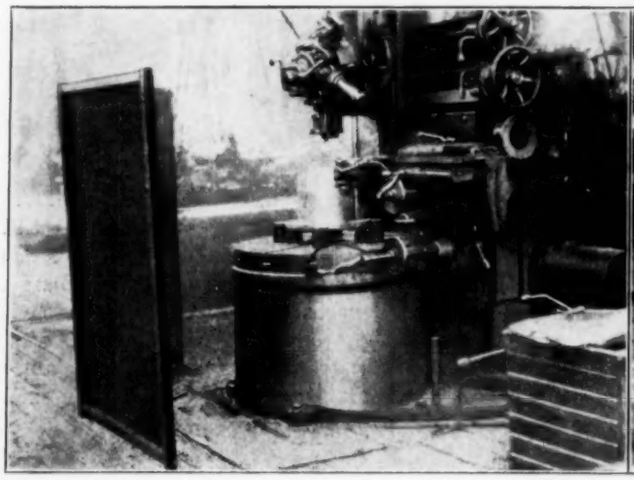


FIG. 5. SCREEN TO PROTECT PASSING WORKMEN

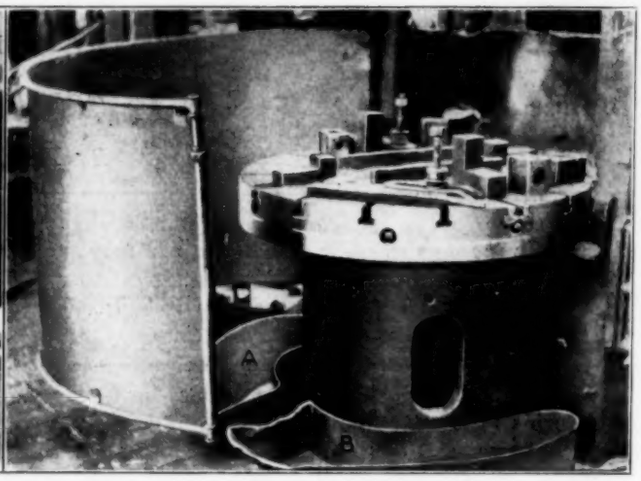


FIG. 6. GUARD USED CLOSE TO BORING MILL TABLE

are not of the flimsy sort, but are made substantially enough to bear the full impact of a man without giving way.

The main interest of the reader, however, is in the machine shop. Here shop-made devices are in evidence everywhere, though only a few of the principal ones can be shown. In Fig. 3 is illustrated the method of railing off the ends of the lathes. This is especially valuable where the end of a lathe is close to a runway, because it keeps both men and material at a safe distance.

Grinders are placed at frequent intervals throughout the shop, and these have not only wheel and dust guards, but heavy adjustable frames containing wired glass are placed over each wheel to protect the eyes of the workmen, as shown in Fig. 4. These are large enough so that the view of the work being ground is unobstructed. The frames are so made that should the wired glass be accidentally broken, it can be easily replaced. A shield of this kind has advantages over goggles in that it is always at hand and the workmen do not have the ingrained dislike for using it that is in evidence where goggles are furnished.

Locomotive brasses are turned at high speed on a Bullard vertical turret lathe, as shown in Fig. 5. Since this machine stands close to one of the runways, the passing workmen were frequently annoyed or injured by hot chips that were thrown with considerable force. This has been remedied by placing a large folding screen between the machine and the runway. On somewhat similar work another type of guard is used. This consists of a circular piece of sheet metal held in a frame, which

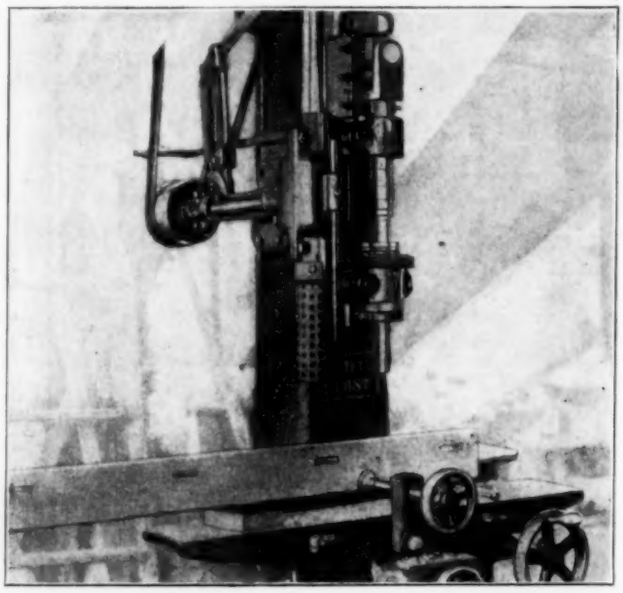


FIG. 7. SLEEVE GUARD ON VERTICAL MACHINE

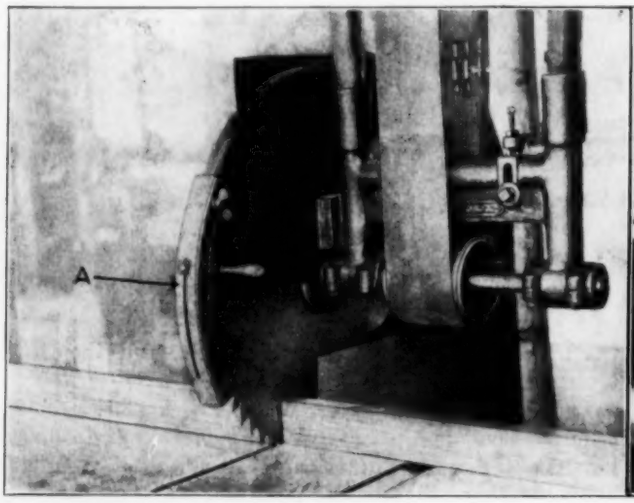


FIG. 8. ADJUSTABLE GUARD ON SWING CUTOFF SAW

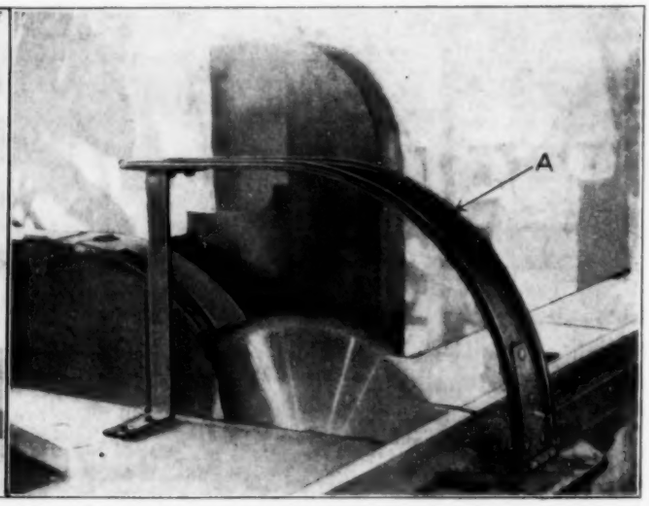


FIG. 9. GUARDS ON TRAVELING CUTOFF SAW

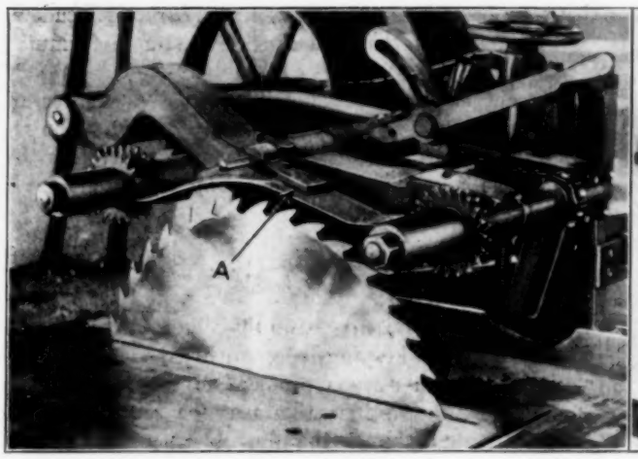


FIG. 10. GUARD FOR TOP OF RIPSAW

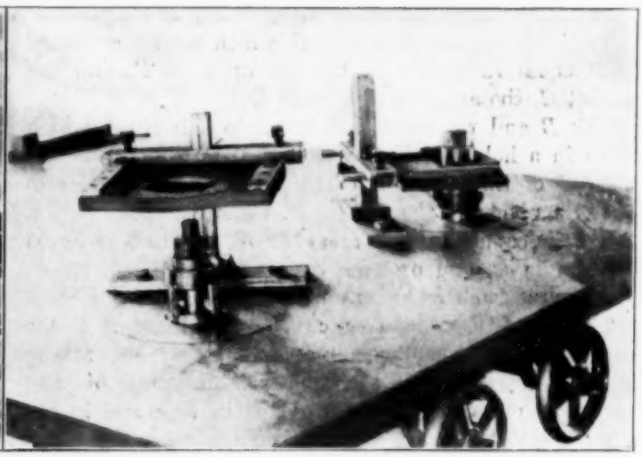


FIG. 11. ADJUSTABLE SHAPER GUARDS

when in place fits closely around the table. This type is shown in Fig. 6. The hinged guard is shown thrown partly around for the removal or insertion of the work. Pans placed as shown at *A* and *B* are used to catch the turnings. These pans are light enough to be easily emptied into a large tote box or wheelbarrow when full. For certain classes of work this type seems to be as good as can be devised, as it stops practically all the chips and is easily swung out of the way.

Gears and belts are guarded as a matter of course, but as these are cared for in the usual way, no views or descriptions are needed.

In the pattern and regular woodworking departments a great deal of time and thought have been expended on the protective devices. The bits on the horizontal boring machines are protected by means of perforated sleeves. These sleeves are bolted securely to the separate boring heads and are so placed that there is practically none of the bit exposed between the head and the work, since the end of the sleeve rests close to the work, and the spindle and bit feed out through it.

One of the sleeves is shown in Fig. 7 applied to a vertical boring machine. The perforations in these sleeves allow the workman to see the bits as they are fed out, but there is little chance for clothing or flesh to catch on either bits or spindles.

An adjustable extension guard *A* has been placed on the large swing cutoff saw shown in Fig. 8. This extension may be slid up or down to clear the work nicely, but lessens the danger of the workman getting his arms or hands on the teeth.

Another type of cutoff saw is shown in Fig. 9. In this type the saw travels on a carriage and is fed through the work by power. It is guarded when in the rear position, as shown. While cutting off, the guard *A* protects the workman from both the saw and flying sawdust. The guards are easily removed for replacing the saw when necessary.

On a rip table used for very large work where a sliding type of guard is impractical, the form shown at *A*, Fig. 10, is used.

The guards for the cutter heads on a wood shaper, shown in Fig. 11, need no explanation.

An Indexing Drill Jig

By M. R. Morrow

Having a quantity of cast-iron rings to drill as shown in Fig. 1, we devised the mechanism illustrated in Figs. 2, 3 and 4, and feel that some of the features used may be of service elsewhere on similar classes of work.

FIG. 1.

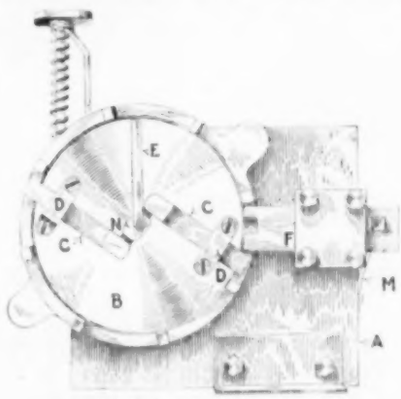


FIG 2.

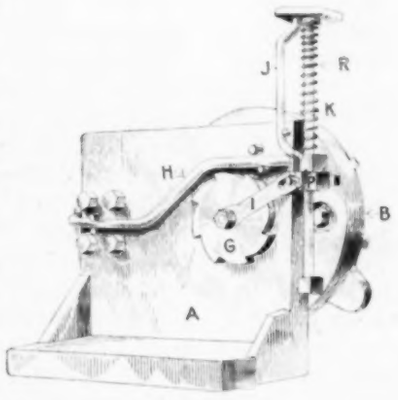


FIG. 3.

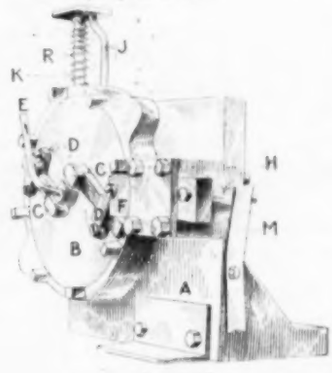


FIG. 4.

AN INDEXING DRILL JIG FOR RAPID PRODUCTION ON CAST-IRON RINGS

This consists primarily of an ordinary angle plate of suitable dimensions *A*, a disk *B*, which carries a central shaft equal in length to the thickness of *B*, and the ratchet *G*, the arm *I* and a nut.

Disk *B* and ratchet *G* are keyed to this shaft, which turns in a hole suitably located in the angle plates. In the end of this shaft *B* a hole was drilled centrally to act as a pivot for the handle *E*. The clamping device, Fig. 2, is composed of a cross-bar *N*, to which is keyed the handle *E*, and on each end is hinged the arms *C*, which slide back and forth in guides *D*.

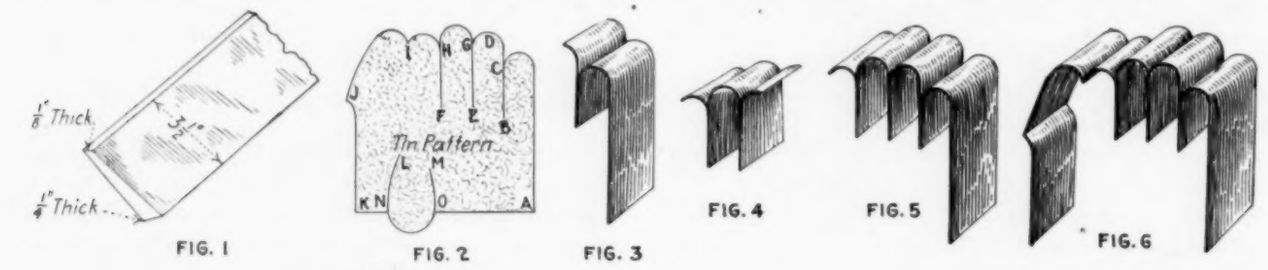
The arm *I* swings free on the ratchet end of the central shaft and carries a spring-actuated pawl working in the ratchet *G*. The part *F* is a flat piece of steel having in one end a slightly elongated hole and in the other a slot to engage the lugs on the ring, the metal above the slot having a hole to guide the drill.

The rod *H*, which operates the disk *F*, is bent as shown in Figs. 3 and 4, the movement being limited by two pins underneath coming in contact with the block of steel, through which it operates.

A piece of steel *P* has one end turned to fit in the slot in arm *I*; the other end has a hole through which the rod *K* projects and to which it is held by a setscrew.

When the rod *K* is forced down, rod *J* comes in contact with *H* and forces it back, bringing *F* with it. As *F* leaves the lug on the ring, the spring-actuated pawl engages the ratchet wheel *G* and turns the disk *B* an eighth revolution, bringing the next lug into position.

Releasing *K*, the spring *R* brings *I* into the position shown and the spring *M* forces *F* ready for drilling as in Fig. 2.



MAKING EDGE-CUTTING DIES

Useful Relation Between the Squares and Numbers

By Donald S. Olds

A few days ago in working out a problem involving the second powers of several numbers I noted a relation between the squares which I have since found very convenient when mathematical tables are not at hand. I have never happened to see this relation stated anywhere and it may be of interest to *American Machinist* readers. It is most easily given by means of a simple formula:

$$a^2 - b^2 = 2\,(a - b)\,b + (a - b)^2.$$

For example, the difference between the squares of 701 and 679 is $2 \times 22 \times 679 + 22^2 = 30{,}360$. The result is obtained in this way much more quickly than by squaring the numbers and subtracting the products if tables of squares are not available.

Making Edge-Cutting Dies

By S. A. Richardson

The making and keeping in repair of edge-cutting dies has always been a serious problem to most firms. In this article is shown how this may be solved. A tin pattern of the style of the die to be made is first supplied. All glove dies are 3½ in. wide by ¼ in. thick, and the pattern is forged in a taper from the back to about ⅛ in. thick on the front, as shown in Fig. 1.

The stock being now ready for bending, take the tin pattern (Fig. 2) and bend the stock from *A* to *B*. Bend a piece from *D* to *C* and weld at *C* up to within ½ in. of the top, using Norway iron as a filler, and grind smooth. Bend a piece from *E* to *F* and from *G* to *D*, weld at *G* and grind smooth. Bend a piece from *I* to *H*, weld at *H* and grind smooth. The result will be two pieces as shown in Figs. 3 and 4. Place these together and weld at *D* (Fig. 2), forming Fig. 5. Next bend the piece from *J* to *I* (Fig. 2) and weld at *I*. Bend the piece from *K* to *J* (Fig. 2) and weld at *J*, forming Fig. 6.

Then bend the piece from *M* to *L* (Fig. 2), forming the thumb-gage, and weld on two straight pieces at *N* and *O*, forming Fig. 7. Weld Fig. 6 to Fig. 7 at *K* and *A* (Fig. 2), forming the complete die, Fig. 8.

As the die is now roughed out, the next process is to fill up the half-inch space left in the welds, using a drill rod as a filler. The die should then be ground smooth on top and bottom and left 3½ in. high. To do this grinding, make a stem to hold a cup-grinding wheel and turn to a standard taper for the drill press, as shown in Fig. 9. Bore two holes in opposite sides of the die halfway up and fasten to the drill table by two hooked bolts. Speed the drill press between 850 and 1,000 r.p.m., and by feeding the wheel down on the die and slowly turning the table with the die attached, the latter is finished to the correct height.

The pattern is then laid on the die, and after a guide line has been scribed around, the die is finished to the correct contour on a grinding wheel. It is then ground back for about 1 in. from the edge to form the bevel.

To temper the die, heat to cherry red, chill in oil and draw temper so that it can be filed to be kept sharp.

Letters from Practical Men

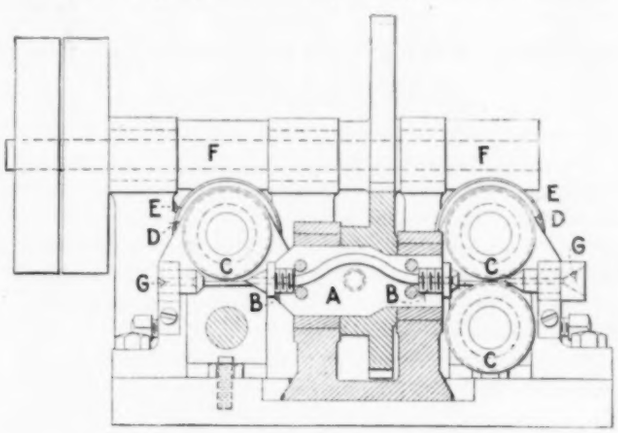
Wire-Straightening Machine

We use a great deal of No. 14 soft iron wire in making cores for gas-stove burner castings. It has been our practice to gather up the used core wires and straighten them by hand. As this was a slow process and just about equaled the cost of new wire, it was decided to make something that would do the work more cheaply. As a result the machine here illustrated was designed.

It consists in the rapidly revolving part *A* containing a curved passage through which the wire is forced, and means for revolving the same and for feeding the wire ahead. The machine is interesting on account of the unusual construction of this revolving part.

This was made of cast iron, in two parts, and machined so that the hard cast surface was left in the curved passage. It was fitted at each end with a steel bushing *B*, drilled to a fairly close fit with the No. 14 wire, while the passage through *A* was cast somewhat larger in diameter.

The wire is fed through by means of two seats of rolls *C* working together through the gears *D*, and driven



WIRE-STRAIGHTENING MACHINE

with the wormwheels *E*, which engage with the worms *F*. Thus the feed speed was made comparatively slow, compared with the rotating speed of *A*, as was necessary to get good results. Bushings are provided outside the rolls at *G* to guide the wire going in (at the right) and coming out (at the left).

This machine is driven by a small motor and is giving satisfaction at a remarkably low cost. Wires can be used over and over again till they are practically burned out in the molds. The machine will straighten wire of any length down to 6½ in. It can be adapted to larger diameters than No. 14 by increasing the diameter of the bushings and the distance between the feed rolls.

The machine was easily constructed and represents a well-paying investment on this class of work.

W. E. Irish.

Rockford, Ill.

Storing Flywheels Safely

It has been stated that much of a man's shop experience is negative—that is, he learns a great many excellent ways in which things should not be done. Anyone who has made a long, frantic leap to dodge a pile of heavy flywheels supposedly leaning against the wall will agree

SAFETY FIRST IN STORING FLYWHEELS

that almost any other method of stacking would be an improvement.

The plan of piling wheels shown requires little space and is absolutely safe. This is simply a suggestion, as any number of variations will occur to the reader, depending on the floor space available and the number of wheels to be piled. There will not be a pound of external pressure on the hubs or spokes tending to distort them, even though the pile is 15 or 20 ft. high, and it will be as solid as the proverbial brick house.

Charles City, Iowa. H. B. McCray.

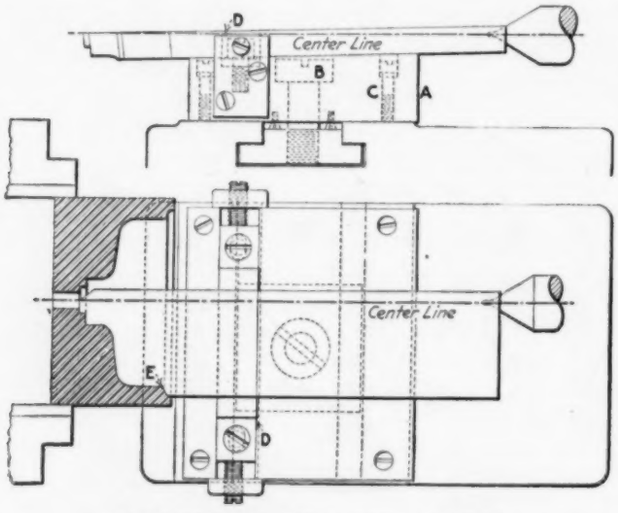
Face-Forming Tool for a Lathe

In the construction of mold dies it is found necessary to turn in the lathe forms of such shape that great difficulty would be encountered if ordinary methods were used. It is required that the pieces turned should be uniform in shape and also nicely finished. The type of form tool and manner of application shown in the illustration were designed to meet the requirements.

Some drawing dies are of such shape as to require the services of an expert die maker in order to obtain good results; hence the value of this tool, which after producing the first die may be marked and laid aside for future use.

The block *A* is fastened to the compound cross-slide by means of the large screw *B*, while the smaller screws *C* facilitate adjusting the height of the tool so that the cutting edge is at the center of the piece being turned. The adjustable posts *D* are clamped firmly on either side of the tool, allowing the operator by means of the cross-slide to move the cutting end of the tool in either direction.

In operation, the piece having previously been roughed out, the operator sets the tool so that the internal diameters of the piece are machined small. The tool is then fed into the piece by means of the tail center. When al-



FACE-FORMING TOOL FOR A LATHE

most to the required depth, the cross-slide is brought into play to obtain the desired diameters. While the tools are generally so constructed that the tail center is in the correct position when at the center line of the lathe, errors in the construction of the tool sometimes necessitate adjusting the center to suit the job. For instance, assuming that it is desired to remove stock from the point *E* without removing any from the center of the piece, the tail center would be moved toward the operator and the desired results obtained.

Newark, N. J. GUSTAVE A. REMACLE.

Turning and Finishing Part of a Circumference

We had some brass embossing rolls to make, with the design on one-sixth of the circumference only, the design to be as shown in Fig. 1.

The method of doing this work was as follows: Two longitudinal slots *A* and *B*, Fig. 1, were first planed along the entire length of the roller. We then chose two suitable lathes, one lathe behind the other as at *E* and *F*, Fig. 2. Between the centers of lathe *E* we placed an old crankshaft *C*, which was connected to a crank *H* on the end of the work *G* by means of a connecting link *K*, to regulate the amount of rotation of the work. A slot *L* was provided in the crank *H*.

A broad-nosed tool $\frac{3}{16}$ in. wide was then clamped in the tool post of lathe *F*. Turning the crank *C* gave an oscillating motion to the work *G*, and by feeding the toolpoint against the work, cuts were taken just as if the roller were revolving.

The brass shell being about 5 ft. long, it will of course be understood that the job was rather tedious. In order to do the work in shorter time, a double-nosed tool

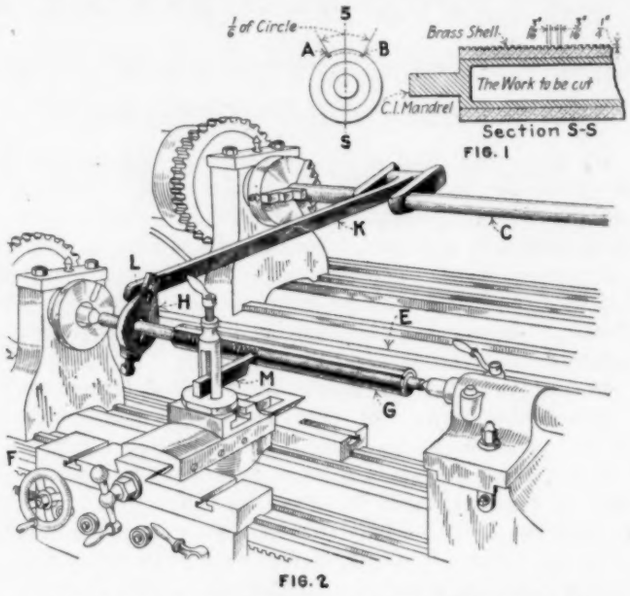


FIG. 2

FIGS. 1 AND 2. TURNING AND FINISHING PART OF A CIRCUMFERENCE

M was substituted for the single-pointed one, and the time required for the job was just about halved.

Shelton, Conn. JOSEPH LIMBRUNNER.

Making Effective Protectors for Machine Ways

Conservation in the machine shop is becoming a big factor of efficiency and any means that will increase the life of a machine tool or prolong its accuracy and usefulness should be carefully considered.

The drawings show the construction of a practical device which can be applied to many types of machines for keeping the ways free from chips and dirt. Its usefulness is self-evident.

The protection consists of a strip of canvas or similar material *N* attached at one end to the side of the table

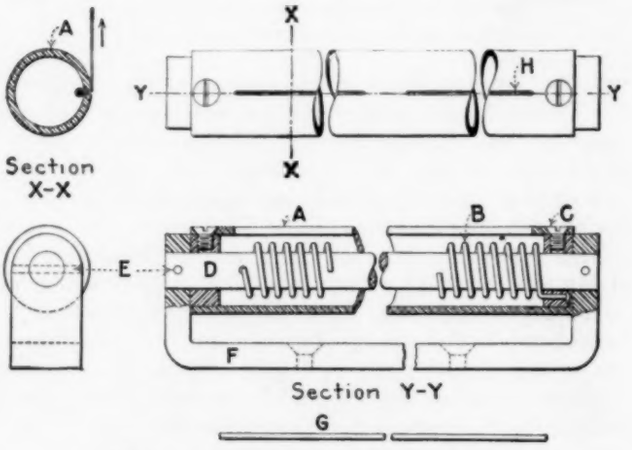


FIG. 1. DETAILS OF THE ROLLER

and at the other end to a roller *M*, which is fastened to the knee. The roller is arranged to wind up or release the strip, as the occasion requires.

In Fig. 1 is shown the design of the roller itself. The roller proper consists of a steel tube *A* with two long slits *H* extending most of its length and leaving only a small bridge between them. This slit should be just wide enough to admit the strip of canvas. The roller is secured

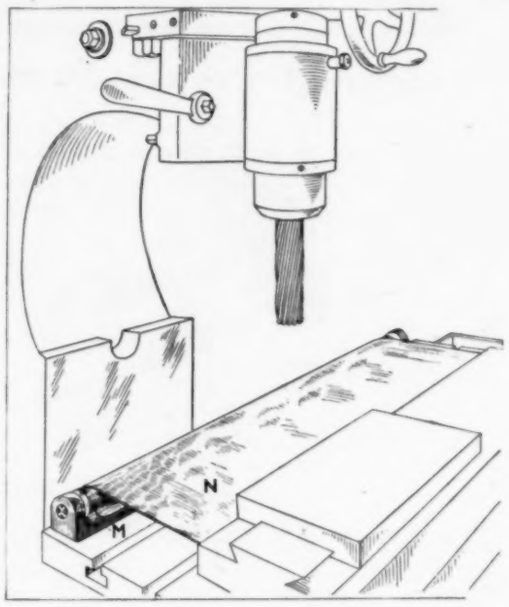


FIG. 2. THE APRON IN PLACE

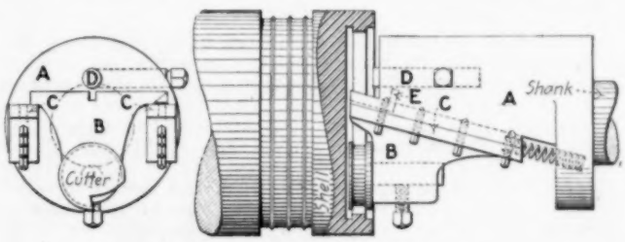
to the end collars by flat-headed screws *C* and is free to rotate on the shaft *D*, which is held in the frame *F* by the pin *E*. One end of the spring *B* is fastened to one end of the shaft and the other end is secured to the bushing in the opposite end. In Fig. 2 it is shown attached to a vertical milling machine. The end of the strip of canvas which is to be fastened to the roller is hemmed up just wide enough to admit the rod *G*. This end of the strip is then slipped through the slot *H* and the rod *G* is then slipped through the hem, thus securing the strip to the roller. The strip is now rolled up on the roller and an initial tension secured before applying to the machine.

The action of this guard is similar to that of a window curtain. However, because of its mechanical construction it will be found more satisfactory.

Bridgeport, Conn. W. Burr Bennett.

Shell-Base Recessing Tool

The illustration shows a recessing attachment that I have specially designed for recessing the base of 4.5 high-explosive shells to be used in a turret that has no cross-



SHELL-BASE RECESSING TOOL

slide. Its advantages, however, are equally pronounced when used upon a machine having a cross-slide.

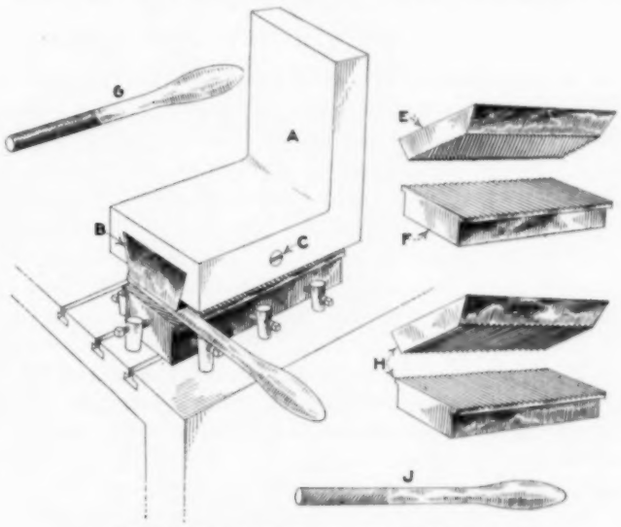
The casting *A* is shaped out to receive the small slide *B*, which has the circular recessing cutter fixed into it. This slide is held in place by a gib *C* on each side of it. At the back of the slide is a spring, which becomes compressed when the operator brings the turret forward and pushes the circular cutter against the base of the shell, continuing to come forward until the stop *D*, which is adjustable, strikes the shell and finishes the recess. A hole is drilled in *A* and a small peg *E* is driven in and the slide *B* is slotted. The peg *E* prevents the slide *B* from sliding off altogether. S. R. Harrington.

Brantford, Ont., Canada.

Knurling Work in the Shaper

Knurling work on lathes and screw machines is common practice, but I wish to present a tool holder and tools for doing this class of work in the shaper. This scheme is not new to me, but may appeal to others as being novel, helping them out a little on some of their problems.

The holder, shown at *A*, is used in place of the swivel block on the shaper, but is held fast while in use. The holder has a dovetail slot *B* for the die, this being fastened by means of the screw *C*. The upper and lower dies are shown at *E* and *F*. These have teeth milled according to the knurl desired, the lower die being milled at an angle opposite to the upper one to produce



KNURLING WORK IN THE SHAPER

the knurl effect shown at *G*. At *H* are dies for spiral work, such as the specimen shown at *J*.

I have used this type of tool for roughing the ends of aluminum and brass pieces $\frac{1}{16}$ to $\frac{1}{4}$ in. in diameter.

East Rutherford, N. J. George F. Kuhne.

Economical Patterns for Temporary Work

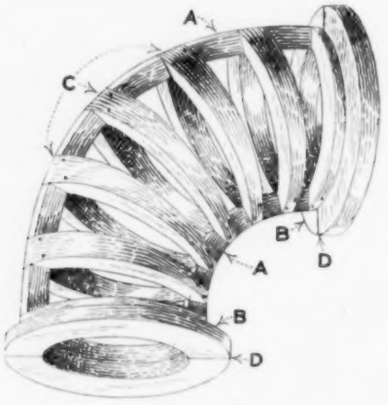
In many shops, especially those handling special work, it often becomes necessary to produce quickly, and with all due economy, patterns for rush jobs or for work which will not be duplicated on further orders. On patterns for medium and heavy work, where the shape is suitable, and especially where green sand cores are to be used, the following method has proved convenient:

A frame is built up to the form of the pattern at the parting line. It is doweled together as usual at

the post of a wooden pattern. Sections are then sawed out to the necessary contour of the pattern and fastened to the frame, about 3 in. apart, in the shape of ribs. The distance between ribs varies, depending on whether the surface to be formed is of double curvature, a single curve or flat.

When the ribs are in place, strips of tin are cut to cover the spaces between the ribs and meet at their centers, and at close intervals are nailed to the ribs with small flat-headed nails, inside and out.

The illustration shows the construction of a pattern for an elbow. The wooden framework is shown at *AA*, the



A BUILT PATTERN

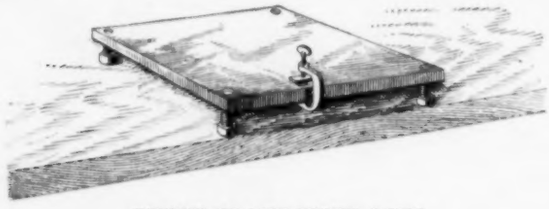
wooden end flanges are at *BB*, while *CC* are the wooden ribs sawed to the proper section and fastened to the frame. The frame and flanges are parted at *DD*.

When finished, if properly made and painted, such a pattern makes a smooth job. It is light, practically waterproof and will last a long time even in continued service.

Detroit, Mich. L. M. FRANCISCO.

A Bench Plate with Legs

The illustration shows a common bench plate, which is raised by drilling and tapping four holes and inserting four machine bolts, with the heads down, for legs.



BENCH PLATE WITH LEGS

It has been found very convenient in a great many cases. A. E. HOLADAY.

Naugatuck, Conn.

Increasing the Swing of a Grinder

The Blanchard Machine Co. was confronted with the problem of finishing a 15-in. steel tubing drum so as to appear well and run true.

Finding that the cost of filing and polishing in a lathe was prohibitive and not productive of good results, attention was turned to the grinding department. There it was found that the largest grinder would only swing 10 in. It was then decided to build up the centers enough to swing the drum. Two pieces were made as shown in Fig. 1, which raised the centers up to 9½ in., as indicated on the rule in Fig. 2.

When operations were begun it was found that, because of the height of the head and tail centers above

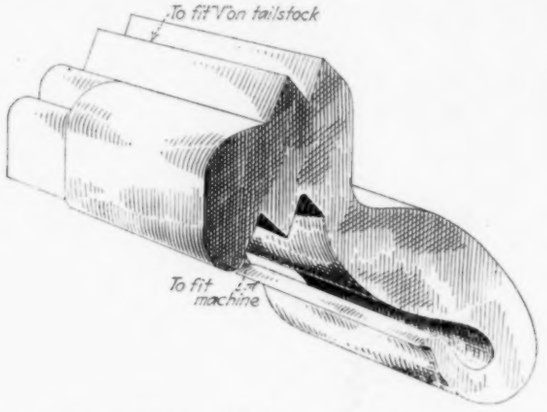


FIG. 1. FORM USED TO RAISE GRINDER CENTERS

that of the wheel, a wavy, chattery finish was produced. After experimenting with different wheels, it was decided to use a carborundum wheel for roughing and an alundum wheel for finishing. The results not being entirely satisfactory, both wheels were then mounted on the spindle together, with a thin fiber washer between

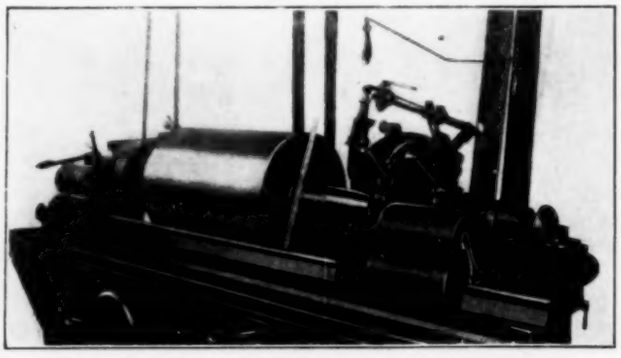


FIG. 2. BLOCKING UP A GRINDER

them. This arrangement produced a smooth, even and very bright finish. Further experiments with a Norton No. 46 wheel in place of the alundum wheel for finishing gave a surface which, while not so highly polished, is considered more satisfactory as a whole.

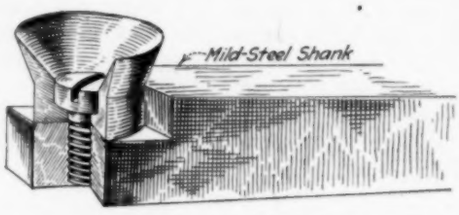
Cambridge, Mass. HARRY J. DOW.

A Machine for Testing the Wearing Quality of Cloth has been produced in Bradford. Relative wearing qualities of different pieces of cloth may be determined by placing them in the machine and giving them a uniform number of rubs, perhaps 200 each. A piece of cloth is clamped in a rigid jaw and passes over a rubbing surface formed by dull blades set in a cylinder. This cylinder makes one revolution clockwise, then one in the opposite direction, and this is recorded by a counter as one rub. The other end of the cloth is clamped to a roller, on which is placed the quadrant, from which any number of weights can be suspended, and thus put the cloth in tension. The machine can be driven by an electric motor. When the cloth is worn through, the machine automatically stops. Leaflets describing this machine and others describing a hydraulic cloth-strength testing machine and a hydraulic yarn-testing machine may be obtained from the Bureau of Foreign and Domestic Commerce by referring to File No. 68,059.

Discussion of Previous Question

Patternmaker's Roughing Tool

The idea of the tool shown on page 471 is many years old; in fact, it is quite 25 yr. ago since I made tools for a similar purpose. Those tools, however, have distinct advantages over the one appearing on page 471. The tool steel cost less, as the cutter is made from bar steel



PATTERNMAKER'S ROUGHING TOOL

and takes the minimum length in material at bar price as against the cost of forging. Another advantage is that the tool is easily made and easily sharpened.

The cutter can be turned to bring the parts which have not been in operation into a cutting position, thereby giving the full circle for wear at each sharpening.

Birmingham, England. W. SMITH.

Lubricating Lathe Centers

Burton A. Prince, on page 866, refers to an interesting matter—the successful lubrication of lathe centers. Since the advent of high-speed steel it is more difficult to prevent the cutting of lathe centers. I have used the white lead as referred to by Mr. Prince, the only objection being its tendency to harden by exposure unless kept under water. Some of the graphite pipe-joint compounds do not harden so quickly and give very good results.

I have found that highly polished lathe centers help to prevent cutting; and carrying that idea a step farther, I polish the centers in the work, and also cut recesses for the lubricant by the following method: I turn, grind and polish the center punch about 1½ in. in diameter, and also a pyramidal punch about the same size; then I drill and countersink the centers about 50 per cent. larger than those usually used for a given size of work. Afterward I drive in the square punch, which cuts four channels, and use the polished punch, which sets down the burrs made by the square punch, and by a number of light blows the whole interior surface of the center becomes compressed and burnished.

Birmingham, Ala. CHARLES C. STEWARD.

On page 866, Burton A. Prince asks what is good practice in lathe-center lubrication. He inquires if a heavy grease is preferable to oil and also mentions a shop that uses common whitelead with oil.

I find in my shop practice that oil alone or whitelead mixed with oil is not always the best for center lubrication. I have used self-oiling centers which were drilled with a $\frac{3}{16}$-in. hole back about 2½ in. and a hole at the top at right angles to feed the oil through, yet that arrangement has not always given the best of results. I find often that a mixture of engine oil, whitelead and graphite is very satisfactory. Graphite, as we all know, is a most positive lubricant and will cling longer by itself than any oil.

I recently made a device for turning eccentric shafts. Accurately placed collars with fixed centers fit over the shaft when it is being turned. These centers have to be kept in excellent condition, else the eccentric part of the shaft will not be parallel to the straight end. This means that proper lubrication is needed to keep these centers from cutting and eventually changing their original positions. By using this oil, whitelead and graphite mixture I have had the best results. The centers are still as true as when first used. W. G. DAVIES.

Fort Wayne, Ind.

Attitude of Employers Toward Military Training

Having read on page 867 Mr. Barbour's reply to my contribution on the subject of military training, I experience almost a feeling of satisfaction in having so successfully set forth what I do not know. It is true that I am not very familiar with the National Guard as it is now conducted in coöperation with the War Department, but several friends who are still in the service have given the assurance that it is more exacting than ever. However, let that pass.

There is a further point to be considered in connection with the matter of vacation allowances. In the smaller establishments the granting of an extra week or ten days with pay may prove somewhat of a financial burden, especially as practically all the employees are likely to take advantage of the offer—not so much by reason of a fondness for military duty as the attraction of an additional vacation. Bear in mind that as at present contemplated these leaves of absence will be either for camp duty as members of the guard or for attendance at instruction camps similar to the Plattsburg experiment. Aside from any financial aspect of the problem, the absence of a considerable number of employees from any department of a business three weeks out of 52 will seriously interfere with keeping the work up to date. This difficulty can be overcome by designating a certain number of men for this extra vacation for, say, three successive years. Then another group can be picked for another three years and so on. This would be equivalent to a term of enlistment, and we are told that in that time a man becomes well-versed in military duty. This would also obviate any tendency on the part of employees to keep on reënlisting and finally spending almost a lifetime in the guard to the detriment of their employer's work.

Jersey City, N. J. H. D. MURPHY.

Europe as Market for American Machinery After the War

The article by F. C. Cornet, "Europe as a Market for American Machinery After the War," on page 861, will I hope bring emphatically to the attention of American manufacturers the possibilities of the European demand for every conceivable kind of labor- and time-saving machinery for use after the war. This demand will be so imperative that a commission of French officials is already in New York to bring to the attention of American machinery manufacturers the great need of modern machinery for every trade and industry in the districts ruined by the struggle.

One condition that American manufacturers will be obliged to consider is the recuperative power of German industries. France and Belgium will be only too glad to favor American goods, but we must not lose sight of the fact that sooner or later Germany will enter the market as a very strong competitor. American ingenuity is offered the market, but on condition that it meets German prices.

In 1913 France imported from Germany over $33,000,000 worth of general machinery and from the United States but $12,000,000 worth of similar goods. Now, $33,000,000 plus $12,000,000 plus the after-war needs expressed in dollars makes a total well worth our best efforts.

A. P. DAUTUN.

Freehold, N. J.

Modifying the Teeth in Gears

An inquiry under the above heading by Charles A. Waring, on page 734, points out a lack in the "American Machinist Gear Book" that I will endeavor to fill.

The most commonly accepted rule for modifying the addendum and dedendum of bevel gears is that given by the Gleason Co., as follows: Gear addendum = 0.3 × working depth of tooth; pinion addendum = 0.7 × working depth of tooth.

This is recommended, I believe, for 14½-, 15-, 17½- and 20-deg. teeth.

Hugo Bilgram gives a tooth modification in the form of angle corrections based upon four-fifths of the theoretical correction. Charts are furnished with each of his machines, and for a general line of work are to be recommended. However, as bevel drive gears for automobiles are confined within certain ratios—say, from three to one to five to one—the Gleason formula will answer. The Bilgram chart is figured for a tooth pressure angle of 15 deg.

Another plan in common use is first to proportion the tooth thickness of gear and pinion according to the relative value of the factor y as used in connection with the Lewis formula $W = SPFy$ for the strength of the teeth; then make gear and pinion addendum a certain part of the corrected tooth thickness. The theoretical correction—cutting off the addendum of the gear at the point of interference, as laid out by Mr. Waring—is also extensively employed. But in many shops the total depth of the tooth is shortened to avoid excessive sliding contact at the end of the arc of recess. This is certainly to be recommended.

This covers general practice; but when considering this problem the thing to be borne in mind is that the teeth should be modified to avoid a weak pinion, *and for no other reason.* The farther the modification is carried the more inefficient and noisy become the gears. The nearer equal the addendums of gear and pinion are kept the longer they will wear and the quieter they will operate.

The extension of the involute (or octoid) curve to a great height above the pitch line renders the pinion tooth difficult to form. The abrupt engagement of the approach and the long slide on the arc of recess are also objections, but a still stronger reason is that modified gears are inefficient and noisy as compared with those of regular design.

Using the Brown & Sharpe standard tooth is of course prohibited on account of the low numbers of teeth in the pinion, 11, 12, 13 and 14 being the general run. Therefore the addendum of the gear must be shortened to avoid extreme undercut of the pinion flank.

I beg to advance the following plan for this correction:

Interference begins with a 30-tooth pinion in the regular 14½-deg. system. Modify the addendum of the gear according to the relation of the value y, as cited for the 30-tooth base and the value of y for the pinion used as follows: Where y for 30 teeth = 0.102 and p= the pitch diameter, then

$$\textit{gear addendum} = \frac{y \textit{ for pinion}}{0.102} \times \frac{1}{p} = \frac{y \textit{ for pinion}}{0.102 \times p},$$

$$\textit{pinion addendum} = \frac{2}{p} - \textit{gear addendum}.$$

For 17¼-deg. modification interference beginning at 21 teeth

$$\textit{gear addendum} = \frac{y \textit{ for pinion}}{0.098 \times p}$$

For 20-deg. modification interference beginning at 16 teeth

$$\textit{gear addendum} = \frac{y \textit{ for pinion}}{0.094 \times p}$$

This modification, coupled with a correction of the relative thickness of gear-and-pinion tooth in favor of the pinion, will produce satisfactory results.

The 20-deg. tooth is not quite as quiet in operation as the 14½-deg. tooth. But the 20-deg. standard tooth is equally quiet as the 14½-deg. tooth corrected according to the Bilgram or Gleason formulas, and is also of about equal strength and will outwear several of them.

The modification should in no case exceed that recommended by the Gleason formula, and as the standard 20 deg. is superior in all respects to the 14½ deg. so modified, it would seem that the 14½ deg. should be dropped altogether, so far at least as bevel gears for automobile drives are concerned; and for that matter, for all purposes.

If a stronger tooth than the 20 deg. with a working depth of $\frac{2}{p}$ is required, the best plan is to shorten the addendum of both gear and pinion an *equal amount.* For this purpose an addendum of $\frac{0.7854}{p}$, as recommended by me in the "American Machinist Gear Book," is in order. I can see no call for the 17¼-deg. form of tooth.

Referring again to Mr. Waring's inquiry, the addendum of 0.1470 in. as found on the gear is not an improvement over the theoretical addendum of 0.1738 in. Evidently the modification of tooth has been carried

much too far. This is a common fault of a system based upon a constant factor of the working depth when applied to a high number of teeth in pinion.

The standard working depth for 4½ pitch is $\frac{2}{4.5}$ = 0.4444 in. The Gleason addendum for the gear = 0.3 × 0.444 = 0.1333 in.

The Bilgram correction based on a 15-deg. tooth for 55 : 16 ratio calls for a face angle correction of 0 deg. 40 min. This angle is to be subtracted from the standard face angle of the gear and added to the face angle of the pinion. The pitch angle gear = 73 deg. 47 min.; pitch angle pinion = 16 deg. 13 min.; face angle gear = 75 deg. 47 min. — 0 deg., 40 min. = 75 deg. 7 min.; face angle pinion = 18 deg. 13 min. + 0 deg., 40 min. = 18 deg. 53 min.; modified angle increment of gear = 1 deg. 20 min.; modified angle increment of pinion = 2 deg. 40 min., and modified gear addendum = 0.1482 in.

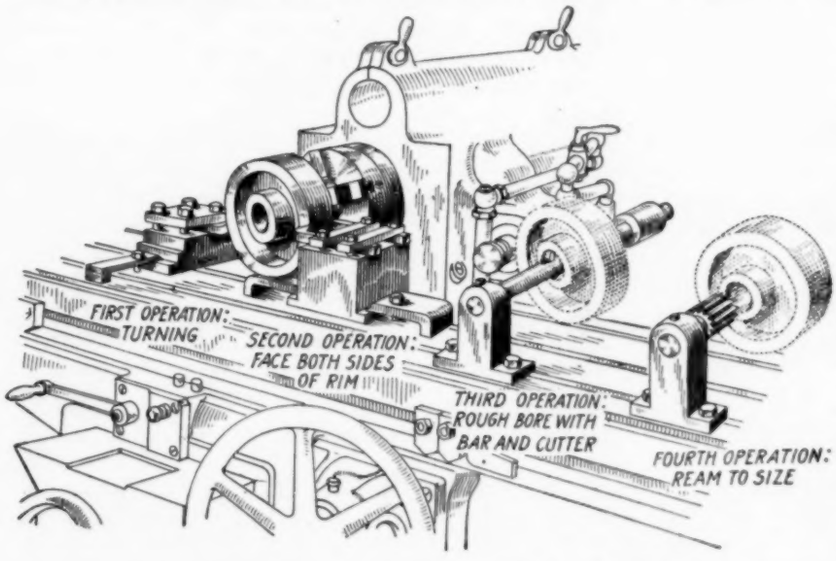
This checks very closely with the addendum found on the gear—in fact, remarkably close when we consider errors in machining the gear blank, and is probably the plan of modification employed. This plan should be used on 14½- to 15-deg. teeth only. The 17¼-deg. tooth does not require the amount of correction to meet even uncalled-for theoretical conditions.

Syracuse, N. Y. CHARLES H. LOGUE.

Being Jarred Out of Your Rut

Reading Mr. Forbes' narrative on page 405, of how O. B. Jennings was jarred out of his rut, awakened memories of a similar experience of mine when I was in charge of a small jobbing shop a good while ago.

The proprietor called me into his den one day and told me that he had just closed a contract to machine 300 gear blanks. He said that prompt delivery on this lot would mean more orders of the same kind for us. His parting command was: "James, I want every machine in the shop to work on this job, and see that they are kept there till it is finished."


FIRST OPERATION: TURNING
SECOND OPERATION: FACE BOTH SIDES OF RIM
THIRD OPERATION: ROUGH BORE WITH BAR AND CUTTER
FOURTH OPERATION: REAM TO SIZE

ARRANGEMENT OF TOOLS ON MILLING-MACHINE TABLE FOR TURNING AND BORING SPUR-GEAR BLANKS

That afternoon the castings were delivered to us, and considering our equipment, it was a good-sized job. We had three lathes, a drill press, a 24-in. planer and a decrepit old milling machine which some philanthropic second-hand dealer had wished on the old man a short time previously. Be it remembered that while the proprietor had owned the shop for many years and had apparently prospered, he was as profoundly ignorant of machine-shop practice as the Sultan of Sulu.

Promptly on receipt of the castings the three lathes were put to work on them; and when I had seen to it that each man was provided with a good stock of suitable tools, I prided myself that the job was off to a good start and confidently expected a pleased smile on the old man's face next morning when he would see how well his orders had been executed. I was young then and had not learned that the pleased smile of the proprietor is about the last thing the foreman of a small jobbing shop should look for. He looked at the 10 finished gears piled neatly on the floor. He looked at the 290 gears not finished, then at the three lathes working industriously, then he looked—no, he glared at me, and demanded to know why I had not put *all* the machines on this work, as he had expressly ordered. Why was the planer not working on them, and why was the milling machine (his pet tool) standing idle?

In vain I explained that these tools were not adapted for the work. He stormed and raved. To him a machine tool was made for any job that came along, and anybody who tried to show him differently was a fool.

Knowing his lack of culture in the fine points of turning gear blanks, I ceased to argue, and placated him by promising to see what could be done toward doubling up. He went away grumbling about boneheaded foremen in general and *his* foreman in particular.

I was floored. In a vague sort of way I turned to the drill press, hoping for some inspiration, and while scratching my head there, my eye wandered casually to the poor old milling machine. I went over and surveyed it as one who wanders through a museum of natural history and sees things fearfully and wonderfully made, but of no practical use, because they really belong in the bone yard.

Did you ever notice how quick your mind will work after you have got the wallop that jars you out of your rut?

As I stood hopelessly before this venerable fossil I suddenly began to see things. There I saw a threaded spindle nose. Ah! Ha! A place to mount a chuck! There was a table with lateral and cross-feeds. What more is necessary for a chucking job than that?

My sketch will show you how the old miller looked when it had been rigged up for action.

It did heroic service, and surprising as it may seem, it beat the lathes 40 ways, as the tools were all fixed and all the adjusting was done by setting the table to reference marks previously located on the edge.

Of course the old man said, "I told you so," when he saw what was going on, and no doubt took the credit to himself. And to give the devil his due, it belonged to him more or less, for had he not jarred me out of my rut

with his caustic remarks I might still be under the impression that the only place where gear blanks could be turned and bored was in a lathe or some kindred machine.

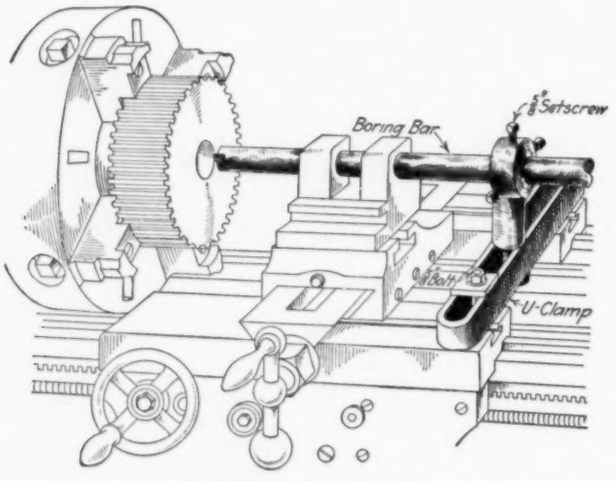
Moral: Never think you have gone the limit.

Buffalo, N. Y. W. J. BISSETT.

Lathe-Tool Jumping and Chattering Remedies

I was interested in the letter of Mr. Bukowsky, on page 956, in regard to jumping and chattering remedies for lathe tools. I have used a device for several years that overcomes the trouble he mentions. The illustration shows it on a 24-in. lathe.

It consists of a U-clamp made of ½x2½-in. steel long enough to reach across the carriage. This clamp is planed on both edges to make it parallel. The boring bar is 2 in. round and about 30 in. long, with a hole in each end for ½-in. square tool steel. One hole is square with the bar and the other at an angle. The ring is about 2½ in. inside and 4 in. outside diameter and 2 in. long, with



A LATHE BORING-BAR RIG

four holes for ⅝-in. tap, equally spaced on the circumference. The distance from the ring to the clamp is made up of 1½-in. pipe with a ⅝-in. rod in the center, held in place by pouring a little melted lead into the pipe.

It is only necessary to loosen the nut on the under side of the clamp to move the cross-slide of the lathe. The bar will take a cut as heavy as the belt will drive.

Spring Valley, Ill. A. H. HOLLADAY.

Turning Split Patterns

In turning split patterns—an operation that always gives the patternmaker trouble—there is much risk that the joint will open and render the work uncylindrical, thereby producing unequal halves. Moreover, the danger of work flying from the centers is not inconsiderable—be the work split or unsplit—by the wedging action of ordinary centers which bend to start a split.

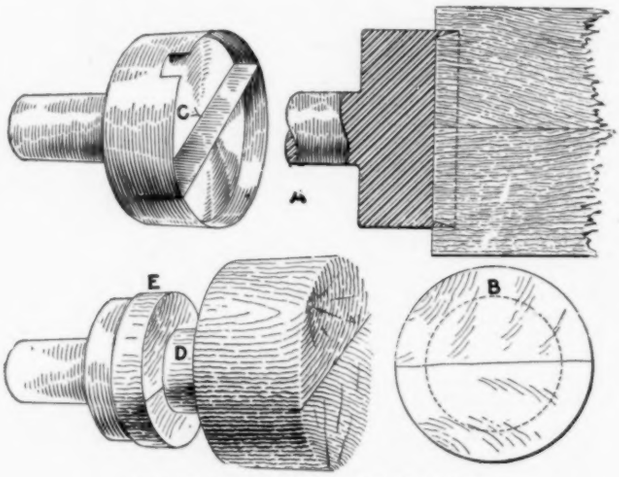
The method shown by S. L. Cook on page 664 obviates some of the trouble, but is, I think, not quite so good as the methods given in the accompanying sketches.

Some patternmakers use centers as shown at *A*. With the compasses set exactly at the joint, a circle *B* is scribed at each end of the piece, the circles being used as guides in applying the centers. The sharp-pointed centralizing ring may be cut away as shown in the small view at the upper left-hand corner of the illustration. The notches then produced intensify the power of the drive, and the forcing in of the centralizing ring tends to close the joint of the pattern.

The idea of your contributor of inserting a spring-steel strip *C* to act as a centralizer could be applied in the manner shown.

The practice followed in turning patterns having small prints at the ends is shown at *D*. The flanges *E* are cut off after the turning processes are completed.

It is necessary in every case to square up the right-hand end of the piece, or the center plate may lie at a



AID IN TURNING SPLIT PULLEYS

small angle to the joint or axis, and the exterior will not then be concentric with the joint. The thicker the center plate the greater will be the error. The piece marked "tail end" on page 664 would, I think, be better without the fiber disk. Fiber is just as likely to heat the center as steel.

Do not half of the small driving pins on the face of the centers face the wrong way? Would it not be better if all the flat faces were in the direction of the drive? FRANCIS W. SHAW.

Manchester, England.

Drills for Deep-Well Work

The article on "Drills for Deep-Well Work," page 955, raises a question. Is it correct in the statement that taper-joint sections are screwed together from the surface to the depth of the hole? I am familiar with the various methods or systems of drilling, and if your correspondent's meaning is as I take it, then this is a new method to me.

The bits shown in the illustration are for the cable or percussion system. The tools generally consist of a bit 4½ to 6 ft. long; auger stem, 16 to 48 ft.; jars (if used), 5½ ft.; sinker (if used), 6 to 16 ft.; rope socket to which is attached wire line or manila cable. A total length of tools for average drilling is 79½ ft. The turning of the pins and sockets is close work; the shoulder and taper must come together at the same time or costly "fishing" jobs are the result. JOHN REID.

Oil City, Penn.

Editorials

A Department of Manufactures

A correspondent, on page 1112, makes a plea for the establishment of a national Department of Manufactures. In so doing he sets forth one trend of thought in regard to the relationship of the Government to manufacturers and manufacturing.

There are many who will agree with him that the Government should serve manufacturers in the same way that farmers are now assisted by the Department of Agriculture, and that this relationship should be on a noncompetitive, nonpaying basis. That is, the Government should take the initiative in studying problems whose solution will benefit American manufacturers, provide the equipment, labor and funds to carry on the necessary research and experimentation, and finally turn over the results for the benefit of the whole industry. This is exactly what is now done for the farmer. The origin of this plan is in the belief that the United States Government should not compete with private laboratories in commercial investigating; and it can surely be classed as paternalistic.

The other line of thought is that the Government should carry on testing work for American industries but that the manufacturers should set the problems and pay the cost. This idea is worked out in the great German laboratories at Gross-Lichterfelde. It ignores the competition between the Government and private laboratories—if such exist—and says, Build up an institution whose report will be accepted without question as representing the best available scientific and technical opinion on the subject studied.

The development of the present Bureau of Standards is leading toward the first result. But it must be confessed that the latter trend would seem to promise the greater advantage for American manufacturers.

Before either one of these plans is brought to maturity in the United States, there is a present practice that needs to be corrected. This is the imposing of secrecy upon manufacturers whose materials are tested for acceptance or rejection under Government contracts. The money of the American people has paid for conducting these tests, primarily of course for the benefit of some department. But no logical reason can be advanced for withholding such information from the public. The results of all such tests should be made known as soon as they are completed. The American people are more interested in knowing what devices and materials are the best for certain purposes than in protecting some manufacturer who is producing an inferior product.

Russian Opportunities and a Commercial Treaty

Every returned American who has studied machinery building in Russia and the opportunities for the sale of American products is almost super-enthusiastic over the outlook. Russia's industrial awakening has come as perhaps the first most important result of the war up to the present time. She has shaken herself free from foreign influence, has mobilized her existing industries, is developing others and is preparing to take up general manufacturing on a vast scale after peace comes.

This viewpoint as regards America's opportunity and Russia's awakening has been forcefully stated by Abbot A. Thayer, who has just returned from a stay of ten months in Russia, during which time he visited many of the important manufacturing cities and industrial districts. To prepare for the business that this country should do in that great empire, Mr. Thayer emphasizes the need of a liberal commercial treaty. The consul-general in Moscow is working for this with encouraging results in his approaches to Russian officials. When we remember that the abrogation of our former commercial treaty with Russia was a political move and realize the present great opportunity for the expansion of American business, there seems to be no reason whatever why a new treaty should not be drawn and signed at once. On the contrary, there are the strongest reasons why American manufacturers should have the benefit of such a connection at the earliest possible moment.

It is evidently in order for American manufacturers to urge upon the Government at Washington that such a treaty be negotiated immediately. The feeling of Russians toward Americans at the present time is most cordial. In addition to the hereditary friendship the Russian people realize that Americans can have no political designs upon them or their territory.

During the last session of the Duma the suggestion was made that in the future loans should be negotiated directly with America instead of through some one of the financial centers of Europe. It was pointed out that these debts might be secured by concessions for the development of natural resources or transportation. It was said that American energy would develop these things more rapidly than would any other, to the immediate advantage of Russia, in addition to the benefit that would come from placing the loan direct with the final holders of the securities.

Springing from this same idea is the suggestion that imports from the United States should go direct from American to Russian ports instead of through Hamburg or Bremen, as in the past. War munitions are of course being shipped direct today, and this may be the beginning of direct importations from this country after the war is over.

One influence of the war in regard to manufacturing is the building up of extensive plants equipped largely with American machinery. Certainly these plants will be able to turn to other products when the demand for munitions ceases. It will not be natural to let this machinery lie idle or to allow the skill acquired by the workmen to go to waste. One result of such a procedure will be the buying of more machinery from the United States in order to balance the equipments.

It is estimated that since the outbreak of war 15,000 lathes have been ordered by Russia and that about one-half have been delivered. An average size is probably the 18-in. Early orders were placed for smaller, and later ones for larger, sizes, including the 20-in. and the 24-in. One reason for this change in size was the placing of contracts for 6-in. shells. These were let in June and July. Screw machines have also been ordered in large numbers, the estimate being about 4,000. Only a few millers and drilling machines have been bought and practically no planers.

These purchases indicate a serious unbalance of equipment for general manufacture. Fresh buying must be resorted to in order to correct this condition.

Beyond the awakening in manufacturing is the development of a great industrial district in the European Urals. Refugees from Poland are being transported to that section by the Government, with the purpose of making use of the great resources of iron, coal, gold, platinum, precious stones and timber. If this purpose is persisted in, machinery in great quantities will be needed.

Mr. Thayer also emphasized the harm that has been done to the good name of American machine tools by some firms who have shipped over "junk." Machines have reached Russia that were so poorly made as to be practically unfit for use. Loose feed screws, scored and cut spindles, poor spindle fits, unscraped and unfitted ways, blow-holes patched with putty or cheap filler, poorly painted surfaces and misalignment are a few of the things charged against them. Some Russian manufacturers are preparing and keeping a blacklist—a list of American manufacturers whose machines they will not buy in the future.

Another way in which the American machine-tool business has been hurt has been through impossible promises of delivery. Reputable firms quoting delivery four, five or six months ahead have had to face the unfair competition of concerns that promised similar machines for immediate delivery. Of course the "immediate promisers" could not "make good," and Americans in general were condemned because of a wretched few.

⁂

Giving Reasons for Unusual Requirements

An intelligent man appreciates knowing the "why" of things, and when he is in a position to do so, he demands that reasons be given for unusual requirements. For knowing the reason, he can act more intelligently in every way.

It is difficult to say how far this giving of reasons can be carried in everyday shop life, but there are many cases where it would help production and add much to the personal satisfaction and good will of the men. This is particularly true of some details of the ammunition work that is being done in various parts of the country.

Many of the specifications and drawings seem unnecessarily severe, and while this may be true in some cases, there is sometimes a very good reason for what may seem to be utter foolishness. In most cases an explanation would be of real service. Ignorance concerning a product makes us critical of seemingly foolish requirements and has a tendency to make us slight them when possible.

Would it not be better in every way if we could have specifications with explanatory notes telling us why it is necessary to have the inside of a high-explosive shell dead smooth, why aluminum is needed in time fuses in place of brass, and a host of other similar data?

Nor is this need of explanation confined to fuse and shell work, for there are many details of machine parts the reason for which is equally obscure.

There are many cases where full information can be given to all who work on the machine or its parts. The intelligent workman will appreciate knowing all about it, whether he turns out more pieces per day or not. The effect is bound to be good, as it makes one more bond between the office and the shop, instead of the czar-like attitude that the men are to do the work and it is none of their business what it is for.

This attitude is slowly but surely giving way to an appreciation of the closer relationship that is necessary or best results in any industry.

⁂

One Effect of War Orders

One of the indirect effects of the war on the machine-building industry is the bringing into the field of new firms that will become more or less firmly established before the present demand falls off. Some of these that only entered the field as subcontractors to regular machine builders will probably consider that the experience gained in this work warrants them in remaining in the machine-building field. Shops which can build and have built cartridge-making machinery on subcontract will very naturally feel that they can build punch presses of a similar size; those that are building Lincoln millers, rifling machinery and other similar work will also be tempted to remain in the field.

There is also another effect being produced in some quarters—the raising of the standards of workmanship in shops which have never before built machine tools. The average shop building woodworking tools does not require the same degree of accuracy as is necessary to turn out a first-class miller or planer. So it is but natural that when one of these shops takes up the building of some good line of machine tools in the present emergency it should find one of its problems the training of its men to do more accurate work. This is found to be the case in several shops of our acquaintance, and the result cannot fail to be beneficial in the long run.

The only danger is that it may have a tendency to do better work than is necessary in some places. For we must not forget that it is just as poor judgment to do work too well as too poorly for the purpose needed.

⁂

The so-called American system of production changed over machine-shop practice from making machines and parts to manufacturing them, from producing single pieces to mass production, from sizing by fitting to sizing by measuring. The progress of the change has depended upon the advancement in the ease and accuracy of making measurements. And in every measurement there are four equally important elements:

The purpose of the measurement.
The method of making the measurement.
The unit of the measurement.
The device by which the measurement is made.

Shop Equipment News

Simplex Shell Lathes

The lathe shown in Fig. 1 has been designed to handle from 8- to 12-in. shells and is made to take 60 in. between centers on a standard 12-ft. bed. It swings 26½ in. over the V's and 15 in. over the carriage bridge. There are four speed changes with a positive drive, dog-tooth clutch. Some idea of the power can be had from the 23-in. drive pulley with 7¼-in. face, at 400 r.p.m.; the main driving gears are 24½ in. in diameter, 3-pitch, 4½-in. face. All gears in the headstock are bronze bushed.

The spindle has a front bearing 8 in. in diameter by 9½ in. long; rear bearing 5x7½ in., with a 2½-in. hole. Oiling is from a reservoir using a cast ring.

The carriage has a 42-in. bearing on the V's and is 15 in. in width across the bridge. It is equipped with a heavy plain rest or a four-tool turret tool post. The crossfeed is by hand, and an automatic longitudinal stop is provided. The apron is of the double-box type; all gears are of steel except the manganese-bronze worm gear. The gear reduction is 80 to 1. A heavy tailstock is provided, the spindle being 4¼ in. in diameter and having a 9-in. travel. A large turret attachment, with stops for each face of the turret, is also furnished when desired, as in Fig. 2. This figure also shows some of the other attachments.

The attachments furnished are for forming, waving, turning tapers, these being designed with special reference to the heavy nature of the work to be done. The forming attachment operates from a slotted cam at the rear by means of a rod and a hardened-steel roller. It can turn the straight as well as the curved portion of the shell. A device on the side of the tool post allows a screw adjustment of the depth of cut while using the forming attachment.

The waving attachment works from a cam on the faceplate in the usual way. It can, however, be moved out of the way by disengaging a split nut. A carriage turret with 2-in. holes can also be supplied to fit the cross-slide. This can be fitted to use the forming attachment where it is necessary to form the inside of the shell. The taper attachment uses a slotted bar adjustable for the taper desired.

The lathe is built by the Cleveland Machinery and Supply Co., Cleveland, Ohio, and weighs 12,000 lb. ready to ship. The maker also furnishes estimated time sheets for machines on some of the larger shells.

Heavy Manufacturing Lathe

The lathe illustrated has been designed to meet the need for a strong, powerful machine for manufacturing purposes. As screw cutting is seldom done on the ordinary shop lathe, this mechanism has been omitted entirely, which greatly simplifies the machine and leaves room to strengthen it in parts under the greatest stress.

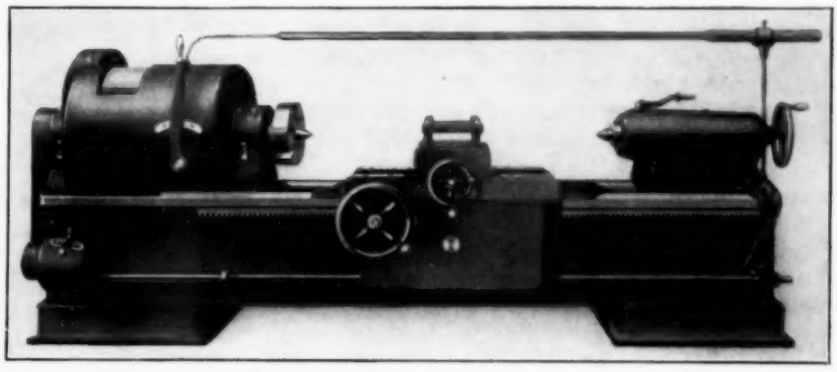


FIG. 1. THE SIMPLEX LATHE FOR LARGE SHELLS

The cross-girts are of the hollow-box type, having substantial webs not only on the top and sides, but on the bottom as well. These girts extend down far enough so that the bottoms continue the lower flange of the bed, giving an exceedingly rigid form of bed construction to resist deflection and stand up under heavy cutting stresses.

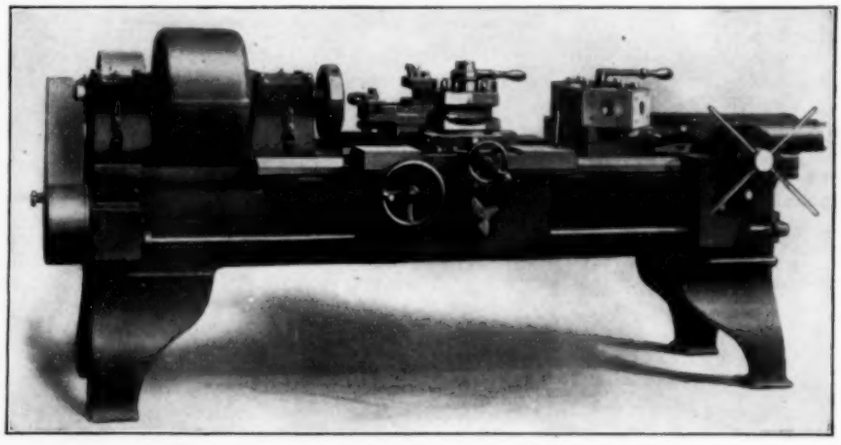


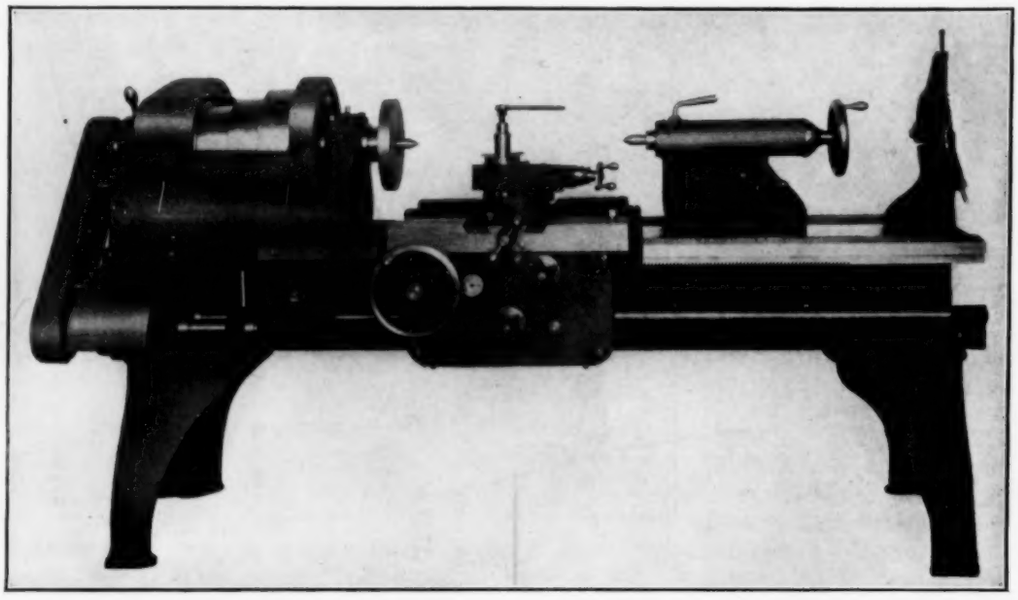
FIG. 2. LATHE WITH TURRET ATTACHMENT

The machine shown is provided with silent chain drive for the feed, but a belt may be used if the customer so desires. In either case a tightener is provided to take out the slack. When a belt is used, this tightener can be engaged sufficiently to give a strong feed, and at the same time the belt can be kept loose enough to slip in case of accident and avoid breakage of weaker parts. All pinions are cut from machinery steel. The main sizes and specifications are as follows:

The headstock is of the modern high-web type; the spindle is of high-carbon steel accurately ground, and runs in phosphor-bronze bearings; the tailstock is so designed as to allow the compound rest to be used at an angle of 90 deg., which is very desirable when turning small diameters. It is also provided with a set-over screw for taper work, and has two locking bolts; the carriage is extra heavy and has an extra-wide bridge; the apron is of the double-plate box form, giving bearing to both ends of the studs. The feed and crossfeed are both operated from the apron. The compound rest is heavy and equipped with taper gibs; the feeds are of the independent geared type, instantly engaged by means of a sliding collar, so made as to make it impossible to engage more than one feed at a time. All gears are provided with neat metal covers. The countershaft has self-oiling friction pulleys and ring-oiling bearings. Regular equipment includes compound rest, large and small faceplates, steadyrest, countershaft and wrenches.

The swing over the bed is 22 in.; over the carriage, 14 in.; distance between centers, 8 ft.; bed, 3 ft. 8 in.; front-spindle bearing, 3¼ in. in diameter by 5½ in. long; rear-spindle bearing, 2½ in. in diameter by 4 in. long; hole through spindle, $1\frac{9}{16}$ in.; centers bored for No. 4 Morse taper; cone-pulley diameters, 9½, 11½ and 13½ in., with 3¾ face for 3½-in. belt; back-gear ratio, 3½ to 1 and 10 to 1; spindle-nose diameter, 2⅞ in., length 2⅜ in., 5 threads to in., United States Standard; tailstock spindle, 2⅜ in. in diameter, with 8-in. travel; number of spindle speeds, with two-speed countershaft, 18; feeds, positive gear driven, four instantaneous changes, from 10 to 60; carriage, length 28 in., width at bridge 7¼ in.; the apron is of double-plate box form, steel pinions with bearings at each end, feed and crossfeed operated by friction cone clutch, feeds reversed in apron; compound-rest travel, 4½ in.; tool post, forged steel slotted for ¾x1½-in. tools; countershaft equipped with one or two 4x14-in. clutch pulleys, as ordered; speed, 200 r.p.m.

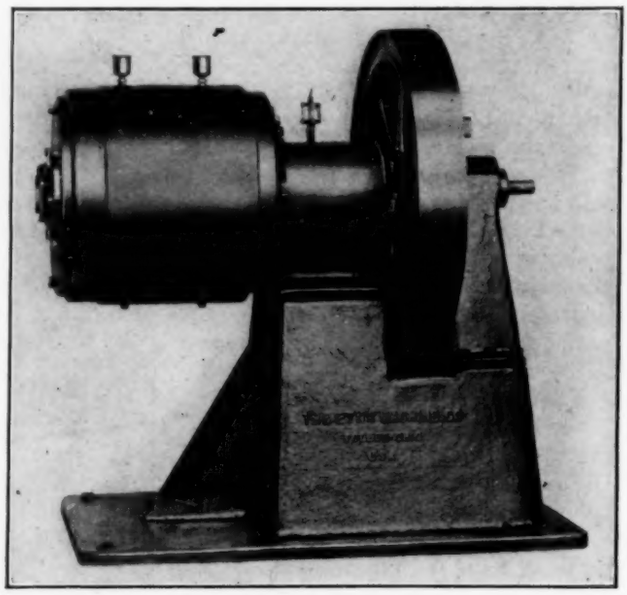
This lathe is a late product of Wm. B. Mershon & Co., Saginaw, Mich. With 8-ft. bed it weighs about 4,000 lb., and boxed occupies 85 cu.ft.



HEAVY 20-IN. DOUBLE BACK-GEARED MANUFACTURING LATHE

Cold Swaging Machine

The machine shown is one of a line being built by the Etna Machine Co., Toledo, Ohio. It is an extra-heavy duty machine of long die capacity. Numerous jobs on solid and tubular stock can be done on this machine that were beyond the capacity of previous models. Dies up to 18 in. in length can be used, thus doing in one operation what formerly required several. This is especially advantageous in tapering long tubes. Bicycle forks can be tapered in one operation at the rate of 300 or more per hour. Stock up to 4 in. in diameter can be swaged, and as the shaft is hollow, tubes of any length can be passed through it. Owing to the special construction of the shaft and die housings, a bright, smooth finish is obtained.



COLD SWAGING MACHINE

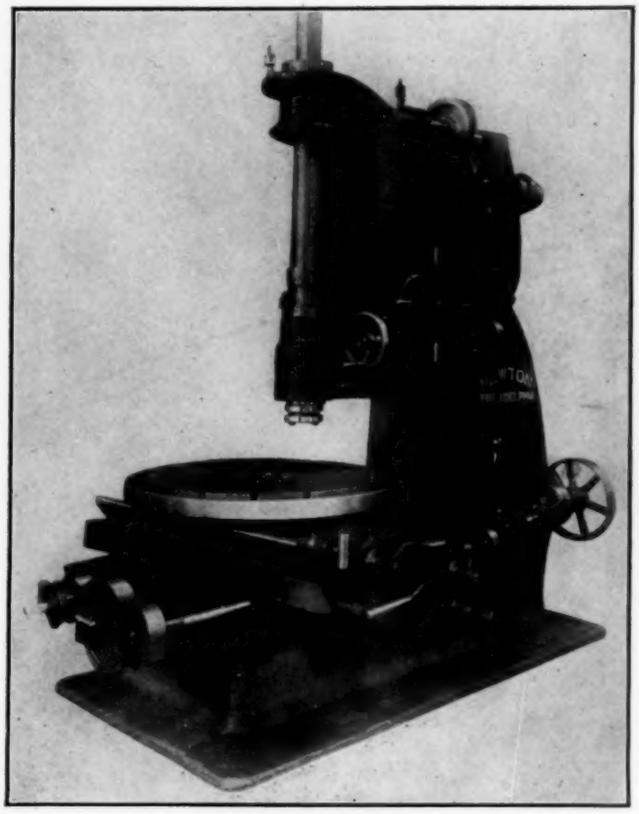
The machine illustrated is used for tapering tubes 18 in. long by 1¼ in. in diameter. The principal working parts are contained in a drum which is bolted to the

housing. The drum is lined with alloy-steel rings 1¼ in. thick and 10⅞ in. inside diameter. Inside these rings is placed a cage containing hardened-steel rolls, ten in number, which revolve and roll over the die blocks, which in turn cause the dies to hammer the work. All the working parts inside the drum are made of the highest grade of stock, with a wide margin of safety, so that breakage is out of the question. The shaft and housing for the dies are made in one piece from a forging, and the shaft housing is lined with high-grade phosphor-bronze bearings. The flywheel is 36 in. in diameter by 5½ in. in width, which is large enough and heavy enough to give stability and power to the machine. Oil cups placed on top communicate with all the working parts.

The principal dimensions are as follows: Bronze bearings, 4½x7 in.; outside diameter of housing, 7 in.; size of rolls, 1 13/16x18 in.; number of rolls, 10; size of drum, 24 in. in diameter by 20 in. long; size of swaging die, 2⅝x1½x18 in.; speed of machine, 300 r.p.m.; floor space occupied, 37x54 in.; net weight, about 5,500 lb.

Heavy Vertical Miller

The illustration shows the latest design of the heavy vertical miller built by the Newton Machine Tool Works, Philadelphia, Penn. Sufficiently flexible control permits the use of end mills as small as ¾ in. in diameter in



VERTICAL MILLER

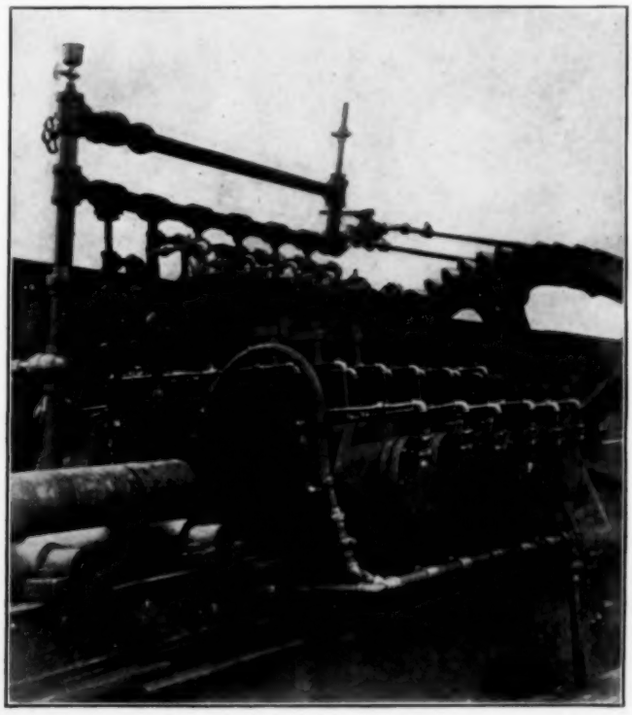
instances where the machines are used as die sinkers; on the other hand the heaviest classes of locomotive milling can be accomplished.

The machine is adapted to motor drive, as changes are obtained through the speed box gearing without removal of the gears. A counterweighted spindle saddle with power vertical feeds and fast power movement is provided. Reversing fast power traverse to the circular, in and out and cross table motions that also have reversing power feeds, and hand adjustments are provided. All of these motions are controlled from a localized position.

The diameter of the circular table over the slots is 42 in. It has a crossfeed of 30 in. and in and out feed of 20 in. The spindle has speeds ranging from 8½ to 232 r.p.m. The table is of corner clamp construction and is surrounded by a pan that is drained through the center into a reservoir. When the circular table is in the forward central position 38-in. outside diameter may be milled. When the table is adjusted to extremes of the cross-slide 48-in. outside diameters with 8-in. diameter cutters may be milled.

Cutting-Off Machines

The cutting-off machine illustrated represents a recent development of the Southwark Foundry and Machine Co., Philadelphia, Penn. The machine is made in two general types, one having a single head movable along a bedplate,



CUTTING-OFF MACHINE

which is used for cutting bars up to about 5 in. in diameter, the second having multiple heads as shown in the illustration. The multiple-head type machine is usually equipped with six heads, although smaller numbers are put on if the length of bar is not sufficient to justify the larger number of heads. The multiple-head type is especially adapted to cut from 5 to 12 in. in diameter.

The machine consists of a series of heavy carriages mounted upon a substantial iron bedplate. Upon each carriage are three air cylinders, each operating a cutting-off tool cutting in the same kerf. The tools are forced into work slightly by the air pressure. The advantage of the air cushion is that the pressure is constant upon the tool, and the depth of cut is dependent upon the hardness of the metal. In addition if the bar is out of round the tool eases up slightly at the high spots, and the cut

is constant in depth. As a result it is possible to obtain the maximum cut that the tool will stand without danger of its being damaged in case an extra-hard spot is encountered at some point in the circumference.

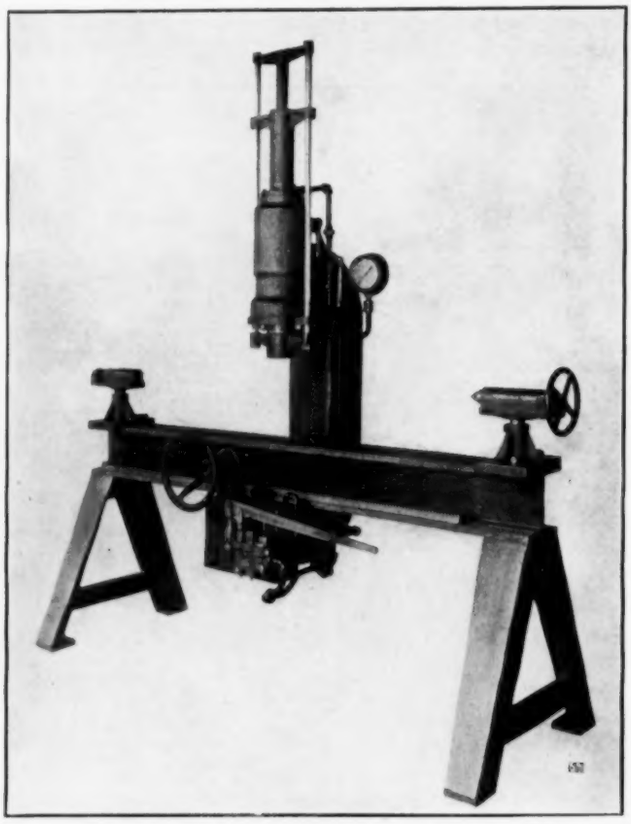
At the end of the bed is a headstock equipped with a chuck for gripping the bar. No tool stock is used, but each cutting carriage has in the center a hardened-steel bushing that serves as a steadyrest. The bars are fed into the machine from the tail end.

These machines are made in a variety of sizes.

Shaft-Straightening Press

In the straightening press shown, which has a 50-ton pressure, the work is held stationary while the press travels by the rack and pinion carried on roller bearings.

The machine is provided with a hand-operated pump having automatic release. The up and down movement of the ram is controlled by air pressure. The adjustable centers swing upward and are carried on heavy springs to yield under pressure.



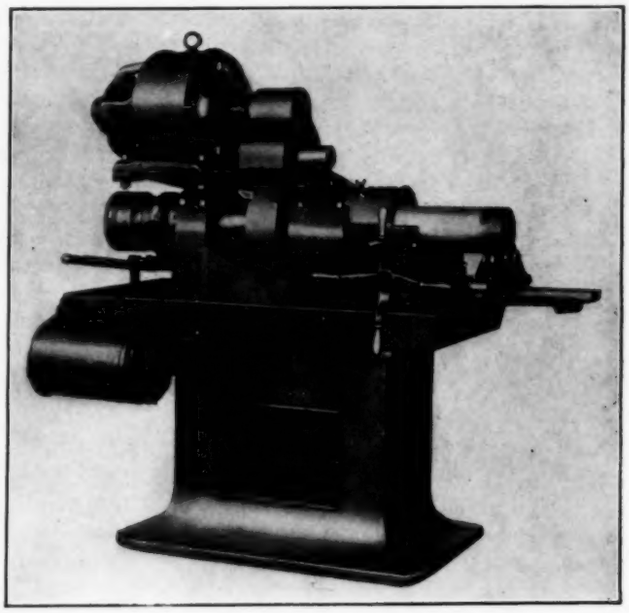
SHAFT-STRAIGHTENING PRESS

The ram has an 8-in. stroke. The maximum distance between centers is 72 in. The machine length overall is 7 ft. 8 in.; total weight, 2,520 lb. The machine is a recent product of the Metalwood Manufacturing Co., Detroit, Mich.

Motor-Driven Cutoff Machine

The machine shown is equipped with motor drive for cutting off solid or tubular stock up to 5 in. in diameter. The motor is a Westinghouse variable-speed, geared directly to the spindle. The motor has a speed range from 575 to 2,300 r.p.m. and a gear ratio to the spindle of 11 to 1.

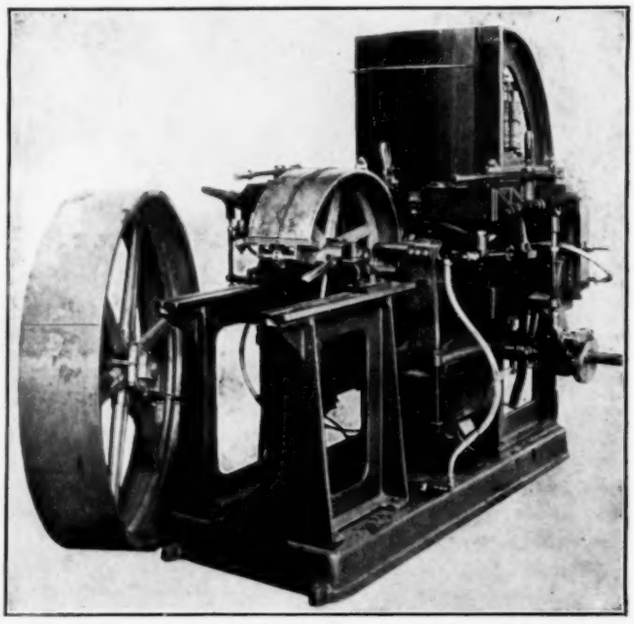
The controller is placed on the front of the machine within easy reach of the operator. The stock is held in by means of a draw-in type of collet fitted with bushings for various sizes. The collet, which is 8 in. long, is operated by means of a hand lever, pawls and quill. Double cutoff tools are used, thereby increasing the speed and insuring a square cut. A centering attachment may be added when desired; it will center the ends to within 0.005-in. limit. As the tools leave a square, smooth finish on the ends, stock may be cut exactly to length. This machine is made by the Etna Machine Co., Toledo, Ohio.



MOTOR-DRIVEN 5-IN. CUTOFF MACHINE

Automatic Electric Welder

The machine shown was made to weld the ring section of pressed-metal pulleys, known as the filler, to the rim itself. This ring, or filler, not only acts as a stiffener



AUTOMATIC ELECTRIC PULLEY WELDER

for the rim, but is the part to which the outer ends of the spokes are attached.

In welding, one-half of a pulley rim is locked by means of a chain-clamping device to a rotating carrier, with the filler and spokes in place as shown. An adjustable mandrel on the carrier insures the proper distance between the center of the pulley and the rim face. Duplicate welding sets operate on each side of the filler, and spot weld intermittently as the work is automatically indexed around.

The mechanical part of the machine is motor driven, and with the work in place, the machine will properly space and weld around the filler until it reaches the end, when it automatically trips. The points are water cooled and will make about 60 welds per minute. These welding points can be set to weld within 2½ in. of the center of the mandrel or supporting shaft, and have a maximum distance adjustment of 12 in. between them. The automatic indexing or feeding device is so arranged that welds from ½ to 3 in. or more apart may be made. Pulleys from 12 in. up to 5 ft. in diameter may be handled, all the necessary adjustments being easily and quickly made to accommodate the various sizes.

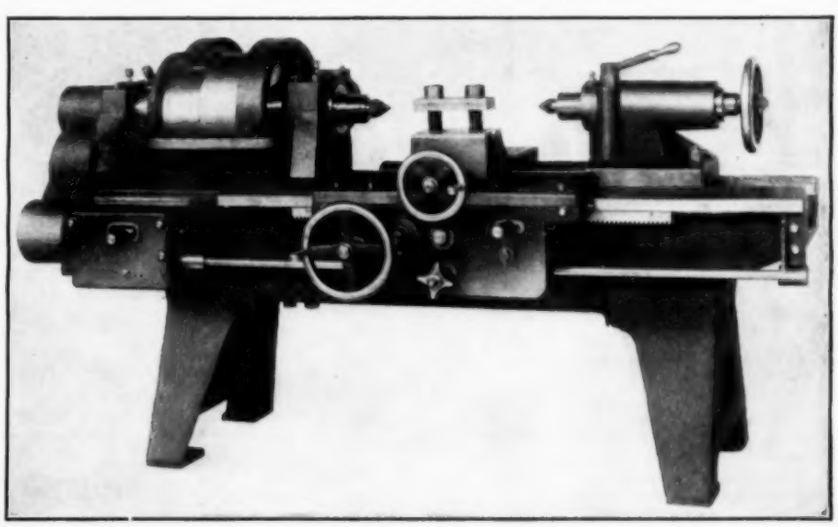
This machine occupies a floor space of about 30x66 in., weighs about 3,500 lb. and was made by the National Electric Welder Co., Warren, Ohio.

Heavy Single-Purpose Lathe

In the illustration is shown another heavy-duty single-purpose lathe that has been developed by the Duplex Printing Press Co., Battle Creek, Mich., as the outgrowth of the demand for shell-turning machines.

In the main the design and construction of this machine follow the conventional lines. The chief aim has been toward rigidity to meet the requirements of shell production.

Two quick changes of speed are provided for in the gear box, in addition to which two slow changes are provided through gear wheels between the head spindle and the upper shaft in the gear box. The speed changes are accomplished by means of two gears on the upper shaft in the gear box, one 4 in. and the other 6 in. in diameter. By transposing the position of these gears, and swinging a quadrant carrying a 10-in. intermediate gear, either may be engaged. When the intermediate gear engages the 6-in. gear on the upper shaft in the gear box, the feed changes in the gear box are $\frac{1}{32}$ and $\frac{1}{16}$ in. per revolution of the spindle; when the 4-in. gear is engaged the feeds are $\frac{1}{24}$ and $\frac{1}{12}$ in.



HEAVY-DUTY SINGLE-PURPOSE LATHE

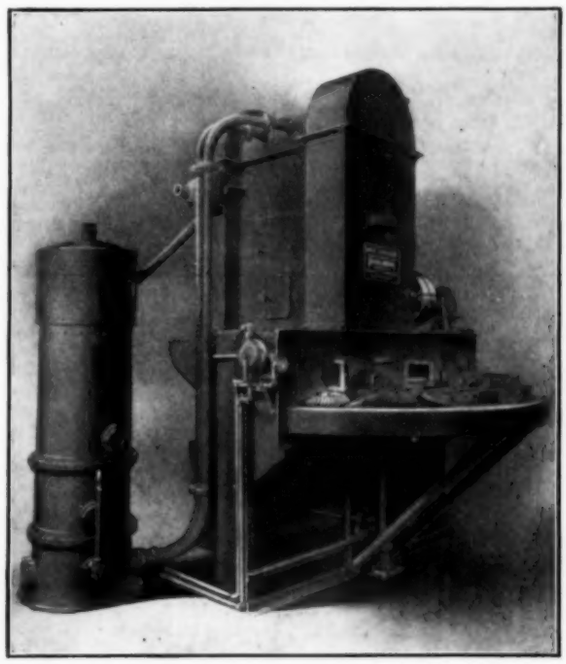
Aside from the bronze bearings in the headstock all bearings are made of semi-steel, with provision for lubrication. Reverse gears are provided in the apron. Some of the principal dimensions follow:

Swing over bed, 19 in.; swing over carriage, 11½ in.; swing between centers, 34 in.; cross-slide ways, 1 in. deep; length of bed, 7 ft. 6 in.; diameter of head spindle, front bearing, 4⅜ in.; diameter of head spindle, rear bearing, 3⅞ in.; spindle speeds, 162; $95\frac{8}{16}$, $22\frac{7}{16}$ and $13\frac{4}{16}$ r.p.m.; net weight, approximately 4,058 lb.

Rotary-Table Sand-Blast

The table form of sand-blast shown was designed primarily for medium and small castings of a nature too fragile or special to be handled safely in the barrel type, and for use where hose sand-blast is not desirable.

The blasting compartment is back of a series of rubber curtains and completely inclosed so that no sand or dust can get outside. The rotating nozzles are at a slight angle and pass over the entire surface of the table. The sand is automatically returned to the sand-blast with the refuse removed.



ROTARY-TABLE SAND-BLAST

The equipment is entirely controlled and operated from in front of the machine, and the controls are all centralized. The table makes one complete revolution in five minutes. As the pieces come out from under the curtains they are turned over.

This machine is a late product of the Pangborn Corporation, Hagerstown, Md.

Prices--Materials and Supplies

PIG IRON—Quotations were current as follows at the points and dates indicated:

	Dec. 17, 1915	Nov. 18, 1915	Dec. 17, 1914
No. 2 Southern Foundry, Birmingham	$14.00	$13.50	$10.00
No. 2X Northern Foundry, New York	19.00	17.25	14.00
No. 2 Northern Foundry, Chicago	18.00	17.50	13.00
Bessemer, Pittsburgh	19.45	17.70	14.70
Basic, Pittsburgh	18.45	16.95	13.45

METALS—Below are the present quotations with a comparison of a month and year ago:

MISCELLANEOUS METALS—NEW YORK

	Dec. 17, 1915	Nov. 18, 1915	Dec. 17, 1914
	Cents per pound		
Copper, electrolytic (carload lots)	20.00	19.25	13.00
Tin	40.00	42.00	33.00
Lead	5.40	5.25	3.80
Spelter	18.00	18.00	5.75
Copper sheets, base	25.00	24.00	18.00
Copper wire (carload lots)	28.25	27.25	14.25
Brass rods, base	27.25	26.25	13.00
Brass pipe, base	32.00	31.00	15.50
Brass sheets	27.25	26.25	13.25
Solder ½ and ¼ (case lots)	24.25	25.50	19.88

MONEL METAL—The following prices hold:

Size, In.	Mill Lengths 8 Ft. and Over: 10,000 Lb. of a Size and Over	6,000 Lb. of a Size and Over	2,000 Lb. of a Size and Over	500 Lb. of a Size and Over	Less than 500 Lb. of a Size and Over
Rounds—Squares	Cents per Pound				
1/16 — 7/16	31.50	32.00	32.50	33.00	36.00
1/2 — 7/16	31.25	31.75	32.25	32.75	35.75
1/2 to 1	31.00	31.50	32.00	32.50	35.50
1 1/16 to 2 1/4	31.75	32.25	32.75	33.25	36.25
Rounds					
3 to 3 1/16	32.50	33.00	33.50	36.00	37.00
Squares					
3	32.50	33.00	33.50	36.00	37.00
Rounds					
3 1/4 to 3 1/2	32.25	32.75	33.25	35.75	36.75
Squares					
3 1/16 to 3 1/2	32.25	32.75	33.25	35.75	36.75
Rounds—Squares					
4 to 4 1/2	33.00	33.50	36.00	36.50	37.50
5 to 6 1/2	36.00	36.50	37.00	34.50	38.50
7	36.50	37.00	37.50	38.00	39.00
Flats	32.50	33.00	33.50	36.00	37.00

Flats not rolled wider than 6 in. or less than ¼ in. thick.
Hexagon Bars two cents (2c) per pound over corresponding size of round rods.

For cutting to any specified length not shorter than 1 ft. add 1c. per lb.

The scrap allowance is 18c. per lb. delivered at works.

SAL SODA sells at 1c. per lb in bbl. lots in New York. The price in Philadelphia is 75c. per 100 lb.

ROLL SULPHUR in 360-lb. bbl. sells in New York at $2.15 per 100 lb.

ZINC SHEETS—The following prices prevail:

Quantity	Cents per Lb.
Carload lots, f.o.b. mill	22.00
In casks, New York	22.50
Broken lots, New York	23.00

STANDARD PIPE—On carload lots f.o.b. Pittsburgh the following discounts hold:

	Black	Galvanized
¾ to 2-in. steel, butt welded	78%	63½%
2½ to 6-in. steel lap welded	77%	62½%
7 to 12-in. steel lap welded	75%	58½%

At this rate prices are as follows:

Diameter	Cents: Black	Cents: Galvanized	Diameter	Cents: Black	Cents: Galvanized
¾-in	2.53	4.19	5-in	34.04	55.50
1-in	3.74	6.30	6-in	44.16	72.00
1¼-in	5.06	8.39	7-in	59.50	98.77
1½-in	6.05	10.02	8-in	62.50	$1.03
2-in	8.15	12.55	9-in	86.25	1.43
2½-in	13.45	21.92	10-in	$1.03	1.70
3-in	17.59	28.68	11-in	1.16	1.92
4-in	25.07	40.87	12-in	1.27	2.10

NAILS—Wire nails f.o.b. Pittsburgh sell at $2; galvanized 1 in. and longer, $4, and shorter, $4.50. These prices are to regular customers and delivery is made at the mill's convenience.

MACHINE BOLTS—From New York warehouse, on sizes from ⅝ in. by 4 in. and smaller 70% off list is discounted; for larger and longer sizes 60% is allowed. These quotations are for bolts having square heads and square nuts. At this rate prices per 100 are as follows:

Length	Diameter: ¼	⅜	½	¾	⅞	1 In.
1½ in.	$0.51	$0.72	$2.08	$3.08	$4.20	$6.04
2 in.	.53	.77	2.23	3.30	4.48	6.40
2½ in.	.56	.82	2.38	3.52	4.76	6.76
3 in.	.58	.86	2.53	3.74	5.04	7.12
3½ in.	.61	.91	2.69	3.96	5.32	7.48

CARRIAGE BOLTS—On ¾ by 6 in. and smaller 65 and 10% off list is allowed; for larger and longer sizes 60% off list is charged . At this rate the price per 100 is as follows:

Length	Diameter: ¼	5/16	⅜	7/16	½	⅝	¾
1½ in.	$0.32	$0.44	$0.60	$0.88	....	....	....
2 in.	.35	.48	.65	.96	....	....	....
2½ in.	.38	.52	.70	1.04	$1.30	$2.30	$3.40
3 in.	.41	.55	.75	1.12	1.41	2.45	3.60
3½ in.	.44	.59	.80	1.20	1.52	2.60	3.80

WROUGHT WASHERS—From New York warehouse the present quotation is $5 from list price. At this rate the following prices hold:

Diameter, In.	Price per 100 Lb.	Diameter, In.	Price per 100 Lb.
5/16	$9.00	1½	$4.30
¾	7.20	1¾	4.20
⅞	6.40	2	4.10
1	5.50	2¼, 2½, 2¾	4.00
1¼	4.80	3, 3¼, 3½	4.20
1⅜	4.40	3¾, 4, 4¼, 4½	4.50

RIVETS—Steel tank rivets 7/16 and smaller sell at 70% off list. On copper rivets 40 and 5% off list is asked. On burs 20% off list is quoted.

NUTS—On hot pressed square nuts $4 off list is allowed and on hexagon $4.20. At this rate, the following prices hold:

Hot Pressed Square: Short Diam.	Per 100 Lb.: Blank	Tapped	Hot Pressed Hexagon: Short Diam.	Per 100 Lb.: Blank	Tapped
½	....	$11.00	½	....	$16.70
5/8	$7.00	8.50	11/16	....	10.30
11/16	5.00	5.90	⅞	$5.40	6.40
¾	4.00	4.70	1 1/16	4.20	4.80
1 1/16	3.50	3.90	1 1/16, 1⅛, 1 3/16, 2	4.10	4.70
1 1/16, 1⅛, 1 3/16, 2	3.40	3.80	2 1/16	4.20	4.90
2 1/16	3.50	4.00	2⅛	4.50	6.30
2⅛	3.80	4.40			

SEAMLESS DRAWN TUBING—The base price is 33c. for brass and 33c. for copper. For immediate stock shipment 2c. is added, which gives the following quotations in cents per lb.:

Diam., In.	Brass	Copper	Diam., In.	Brass	Copper
¾ to 3	35.00	35.00	5	41.50	41.00
3½	36.50	36.00	6	42.50	42.00
4	37.50	37.00	7	44.50	44.00
4½	39.50	39.00	8	46.60	46.10

COPPER BARS—The base price is 27½c. per lb.

STEEL SHEETS FROM JOBBERS' WAREHOUSE, NEW YORK

	Dec. 17, 1915	Nov. 18, 1915	Dec. 17, 1914
	Cents per pound		
No. 28 Black	3.15	3.00	2.60
No. 26 Black	3.05	2.90	2.50
Nos. 22 and 24 Black	3.00	2.85	2.45
Nos. 18 and 20 Black	2.95	2.80	2.40
No. 16 Black	2.90	2.70	2.35
No. 14 Black	2.80	2.60	2.25
No. 12 Black	2.70	2.55	2.20
No. 28 Galvanized	5.25	5.00	3.50
No. 26 Galvanized	4.95	4.70	3.20
No. 24 Galvanized	4.80	4.55	3.05

STEEL SHAPES FROM JOBBERS' WAREHOUSE, NEW YORK

	Dec. 17, 1915	Nov. 18, 1915	Dec. 17, 1914
	Cents per pound		
Steel angles base	2.40	2.30	1.85
Steel T's base	2.45	2.35	1.90
Machinery steel (bessemer)	2.40	2.25	1.80

The above prices are for angles 3 in. by ¼ in. and larger and tees 3 in. and larger.

BABBITT METAL—Best grades are selling from 55 to 60c. per lb. Ordinary commercial grades command 25 to 30c. per lb.

WELDING MATERIAL (SWEDISH)—Prices are as follows:

Welding Wire	Cents per Lb.
3/32, 1/16, 5/64, 1/4, 5/16, 3/8	8.50
No. 8, 5/32 and No. 10	9.25
1/8	10.00
No. 12	11.00
3/32, No. 14 and 1/16	12.00
No. 18	14.00
No. 20	16.00

Special Welding Steel	
1/8	33.00
5/32	30.00
3/16	28.00

Cast-Iron Welding Rods	Cents per Lb
1/4 by 19 in. long	22.00
5/16 by 12 in. long	26.00
5/16 by 19 in. long	20.00
1/2 by 21 in. long	20.00

Vanadium Wire in Coils or Sticks	
1/16	15.50
3/32	15.00
1/8	14.00
5/32	12.00
3/16 and larger	11.00

The above prices are subject to change according to quantity and shipment desired.

SWEDISH (NORWAY) IRON—This material sells at $4.25 per 100 lb. f.o.b. New York.

ANTIMONY—For spot delivery on Chinese and Japanese brands, duty paid, 40c. per lb. is asked.

COLD DRAWN STEEL SHAFTING—To consumers requiring fair-sized lots the price is unchanged at 35% off list.

OLD METALS—The following are the dealers' purchasing prices in New York:

Copper	Cents per Lb.
Heavy and crucible	16.50
Heavy and wire	16.00
Light and bottoms	14.00
Lead	
Heavy	4.25
Tea	4.00

Brass	Cents per Lb.
Heavy	11.25
Light	9.00
No. 1 yellow rod turnings	11.50
No. 1 red turnings	11.00
Zinc	10.00

COKE—Below are the prices per net ton at ovens, Connellsville, and cover the past four weeks:

	Nov. 27 1915	Dec. 4 1915	Dec. 11 1915	Dec. 18 1915
Prompt furnace	$2.15@2.25	$2.15@2.25	$2.15@2.25	$2.50@3.00
Prompt foundry	2.90@3.15	2.90@3.25	2.90@3.25	3.25@3.75

COTTON WASTE—White cotton waste at New York sells at 6½ to 9½c. per lb., and colored mixed at 4½ to 8c.

OILS—Prime winter lard oil sells at 92@96c. per gal. in 5-bbl. lots; cottonseed crude, f.o.b. mill, 55c.; and linseed, raw, in carload lots, at 61c.

New and Enlarged Shops

If you are in need of machinery or supplies, the first thing to do is to consult the Buying Section. If you cannot find just what you want, send us particulars, and we will be glad to publish it free of cost, thus putting you in touch with reliable manufacturers.

METAL WORKING

NEW ENGLAND STATES

Bids are being received for the construction of a two-story, 50x160-ft. garage at Allston, Mass., for R. B. Gryzmish, 1817 Commonwealth Ave., Brighton, Mass.

J. A. L. Blake has awarded the contract for the construction of a garage at Beverly Farms, Mass. Estimated cost, $10,000.

The C. P. Lovering Co. will establish a plant at Cambridge, Mass., for the manufacture of electrical goods.

The Broad Gauge Iron Works, 77 Portland St., Boston, Mass., is building a one-story, 65x140-ft. factory at Everett, Mass. Estimated cost, $15,000.

The G. W. Prentis & Co., manufacturer of wire, is building a three-story, 37x60-ft. factory at Holyoke, Mass. Estimated cost, $15,000.

Plans are being prepared for the construction of a four-story, 50x100-ft. factory at 17 Stewart St., Lynn, Mass., for the Campbell Electric Co.

The contract has been awarded for the construction of a three-story, 50x160-ft. addition to the plant of the Wright Wire Co., Palmer, Mass.

The contract has been awarded for the construction of a two-story, 184x185-ft. foundry at Readville, Mass., for the Stafford Co. Estimated cost, $40,000. Noted Dec. 9.

The Quigley Furnace and Foundry Co., 105 West 49th St., New York, N. Y., is in the market for brass rolling mill equipment for its plant at Springfield, Mass.

The contract has been awarded for the construction of a foundry at Taunton, Mass., for the Evans Stamping and Plating Co. Noted Dec. 9.

Plans being prepared for the construction of a one-story garage at Winchester, Mass., for W. E. Schraaft, 160 North Washington St., Boston.

Bids will soon be received for the construction of a one-story, 60x62-ft. garage at Worcester, Mass., for J. Francis Southgate, 5 Crown St. Estimated cost, $15,000.

The contract has been awarded for the construction of a 65x102-ft. garage at Worcester, Mass., for the Worcester Gas Co.

The contract has been awarded for the construction of a factory at Worcester, Mass., for the Wright Wire Co. Estimated cost, $25,000.

Plans are being prepared by Bernhardt Doehrer, Arch., 15 Fairfield Ave., Bridgeport, Conn., for the construction of a one- and two-story, 60x100-ft. garage at Bridgeport.

The contract has been awarded for the construction of a two-story garage at Goshen, Conn., for W. B. Lashen, 647 Clinton Ave., Bridgeport. Estimated cost, $15,000.

The S. K. F. Ball Bearing Co. has awarded the contract for the construction of a plant at Hartford, Conn. Noted Sept. 23.

We have been advised that the C. Cowles & Co., New Haven, Conn., is in the market for six furnaces and crucible puller. Noted Dec. 9.

MIDDLE ATLANTIC

A two-story addition will be built to the plant of the Pierce-Arrow Motor Car Co., 1661 Elmwood Ave., Buffalo, N. Y. Estimated cost, $12,000.

Bids are being received by the Endicott Forging and Manufacturing Co., Endicott, N. Y., for an addition to its plant. Sacket & Park, Syracuse, N. Y., is Arch.

The contract has been awarded for the construction of a six-story garage and service station at 67th St. near West End Ave., New York, N. Y. (Borough of Manhattan), for the Hudson Motor Garage of New York, Inc., 1842 Broadway. Noted Dec. 2.

Plans are being prepared by J. M. Felson, Arch., 1133 Broadway, New York, for a garage on 127th St. near Broadway, New York, N. Y. (Borough of Manhattan), for the Klein Operating Co. Estimated cost, $20,000.

Plans have been prepared by W. S. Bessell, Arch., 3 West 29th St., New York, N. Y. (Borough of Manhattan), for a garage at Webster Ave. and 170th St. (Borough of Bronx) for the Manderkin Building Co. Estimated cost, $10,000.

A. H. and C. S. Mallory, Binghamton, N. Y., have purchased the plant of the Owego Bridge Co., Owego, N. Y., who will alter and enlarge same for a fabricating plant for the Binghamton Bridge Co. and the Syracuse Bridge Co.

Fred Smith, Poughkeepsie, N. Y., plans to build a two-story, 30x142-ft. garage. Estimated cost, $40,000. W. J. Beardsley, 49 Market St., Arch.

The contract has been awarded for the construction of a one-story, 168x264-ft. addition to the plant of the North East Electric Co., Rochester, N. Y., manufacturer of motors, etc. Estimated cost, $20,000.

The Rochester Motor Co. has awarded the contract for the construction of a one-story, 65x150-ft. factory at Rochester, N. Y. Estimated cost, $10,000.

The contract has been awarded for a one-story, 60x151-ft. factory at 176 Anderson Ave., Rochester, N. Y., for the Rochester Stamping Co., manufacturer of tin ware, Rochester, N. Y. Noted Nov. 4.

The contract has been awarded for the construction of an annealing building for the Crucible Steel Co. of America, Syracuse, N. Y. Estimated cost, $15,000. E. L. French is Mgr.

The Syracuse Malleable Iron Works, North Geddes St., Syracuse, N. Y., is building a one-story, 110x150-ft. addition to its foundry.

We have been informed that the garage, machine shop and carriage factory of Davis I. Weeden, Asbury Park, N. J., which was recently destroyed by fire, is being rebuilt. Estimated cost, $6,000. Clinton B. Cook, Arch. Noted Nov. 4.

The Acme Manufacturing Co. has moved its plant from 205 Paterson St., Paterson, N. J., to Boonton, N. J. The company manufactures auto parts and accessories and is in the market for new machinery. L. W. Haas, Supt.

Fire, Dec. 10, destroyed the foundry of Cunningham Bros., Boonton, N. J. Loss, $45,000.

F. G. Ring, Arch., 280 North Broad St., Elizabeth, N. J., has prepared plans for a machine shop for S. L. Moore & Sons Corporation at Elizabeth, N. J. Estimated cost, $200,000.

The W. M. Crane Co., Jersey City, N. J., manufacturer of gas appliances, will build an addition to its plant on Gates Ave.

The contract has been awarded for the construction of a two-story garage, machine shop and automobile salesroom for George T. Casebolt, Broad St., Newark, N. J. Estimated cost, $20,000. Noted Dec. 2.

The Public Service Railway Co., Newark, N. J., plans to build a new car building plant at Burlington, N. J.

The Solid Steel Tank Co., has acquired a site on South 21st St., Newark, N. J., and will establish a plant for the manufacture of its products. Matthew Donovan, Rahway, and George Hills, Westfield, N. J., are interested.

The Trenaman Electrical Dental Manufacturing Co., New York, N. Y., manufacturer of electrical dental appliances, has acquired a factory on Halsey St., Newark, N. J., and will equip it for the manufacture of its specialty.

Plans are being prepared for a one-story, 173x300-ft. shop at Rockaway, N. J., for the International High Speed Steel Co., 99 Nassau St., New York, N. Y.

A one-story addition will be built to the plant of the American Steel and Wire Co., Trenton, N. J.

The Hyatt Auto Top Co., Trenton, N. J., will establish a plant on Wood St., Trenton.

The R. C. Maxwell Co., Trenton, N. J., has acquired a site on East State St. on which it will build a plant for the manufacture of outdoor electric signs.

The Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn., will establish a plant on 28th St. for finishing shells and is in the market for lathes and other shell equipment.

The contract has been awarded for the construction of a one-story, 60x550-ft. machine shop for the Midvale Steel and Ordnance Co., Nicetown, Penn.

Plans are being prepared for a three-story, 150x300-ft. factory at Oakmont, Penn., for the Autocar Co., 23d and Market St., Philadelphia, Penn. Stearns & Castor, Stephen Girard Bldg., Philadelphia, Arch.

Bids have been received for the construction of a one-story, 70x195-ft. factory at Philadelphia, Penn., for the Miller Lock Co.

The Pennsylvania Equipment Co., Coleman Bldg., Philadelphia, Penn., is in the market for a second-hand shear and a roller straightener or gag press. J. E. Bough is Mgr.

Philadelphia Forge Co., Philadelphia, Penn., has awarded the contract for the construction of factory buildings at Milnor and Bleigh St. Estimated cost, $10,000.

The Heppenstall Forge and Knife Co., Pittsburgh, Penn., is building several large additions to its plant.

We have been informed that the United States Gauge Co., 67 Wall St., New York, N. Y., is building an addition to its plant at Sellersville, Penn. Machinery will be required for a brass foundry and tool shop and stamping and brass turning machinery. Estimated cost, $50,000. Noted Dec. 9.

The contract has been awarded for the construction of machine shop No. 4 for the Bethlehem Steel Co., South Bethlehem, Penn. Estimated cost, $100,000. Noted Nov. 25 and Dec. 16.

The contract has been awarded for the construction of a one-story, 60x90-ft. foundry at Williamsport, Penn., for the Housel & Blair Machine Co. Estimated cost, $5,200.

The contract has been awarded for the construction of a two-story, 33x130-ft. garage at Washington, D. C., for John H. Schwarzmann.

Plans are being prepared for the construction of a two-story, 55x145-ft. garage for Thomas W. Smith, Washington, D. C.

SOUTHERN STATES

Atlantic Coast Experimental Association has awarded the contract for the construction of a building for the manufacture of hydroplanes and hydro-aëroplanes at Newport News, Va. Estimated cost, $10,000.

The contract has been awarded for the construction of a two-story, 125x200-ft. plant at Warwood, W. Va., for the Merchants & Evans Co., Inc., manufacturer of tin plates and metals.

The Wheeling Mold and Foundry Co. has awarded the contract for the construction of a two-story, 57x140-ft. addition to its plant at Wheeling, W. Va. Estimated cost, $10,000. Noted Sept. 30.

The Shannon Bed Spring Co., Louisville, Ky., recently incorporated with $15,000 capital stock, will establish a plant for the manufacture of springs. Wooford Shannon is interested.

MIDDLE WEST

The Globe Motor Car Co. has awarded the contract for the construction of a four-story, 60x200-ft. garage and salesroom at Canton, Ohio. Estimated cost, $80,000. Noted Oct. 14.

The A-1 Metalic Products Co., Cleveland, Ohio, will establish a factory on Canal Rd., Cleveland.

The contract has been awarded for the construction of a two-story, 44x126-ft. factory at Cleveland, Ohio, for the Beverly Machine Co. Estimated cost, $8,500.

The Chandler Motor Car Co. will construct a one-story, 60x100-ft. addition to its plant at East 131st St., Cleveland, Ohio. Estimated cost, $2,500.

The Cleveland Automatic Machine Co., 2269 East 65th St., Cleveland, Ohio, will establish a factory for the manufacture of shell casting machinery.

Preliminary plans are being prepared for the construction of a plant at Cleveland, Ohio, for the Cleveland Galvanizing Works. Noted Nov. 25.

The contract has been awarded for the construction of a two-story addition to the plant of the Cleveland Steel Barrel Co. at Cleveland, Ohio. Estimated cost, $17,000. Noted Dec. 9.

The National Brass Bedstead Co. will establish a factory on Canal Rd., Cleveland, Ohio.

The Perfection Cap and Can Co. will establish a factory on Canal Rd., Cleveland, Ohio.

Plans are being prepared by John Graham, Arch., 767 Hippodrome Bldg., Cleveland, Ohio, for the construction of a garage at Cleveland for S. P. Shane.

The Vichek Tool Co. will construct an addition to its plant at 10,701 Quincy Ave., Cleveland, Ohio.

Plans are being prepared for the construction of a one-story, 75x225-ft. forging plant for the Horsburgh Forging Co. at Collinwood, Ohio.

Work will begin in the spring on the construction of a factory at 839 Reynolds Ave., Columbus, Ohio, for the Shaw Wire Fence Co. Noted Nov. 18.

C. B. Gordon, New Lexington, Ohio, will construct a machine shop and garage at Crooksville, Ohio.

The contract has been awarded for the construction of a three-story garage at Third and Kenton St., Dayton, Ohio, for W. F. Stark. Estimated cost, $30,000. Noted Oct. 28.

The contract has been awarded for the construction of a factory at Euclid, Ohio, for the White Automobile Co., Cleveland. Noted Dec. 9.

We have been advised that Bell & Brown, Galion, Ohio, is in the market for concrete mixers, hoists, tracks and cars and elevators for making, lifting and conveying concrete sewer and culvert pipe. J. M. Bell is Secy. Noted Dec. 9.

The Carnegie Steel Co., Youngstown, Ohio, plans to build a plant at Girard, Ohio. Estimated cost, $10,000,000. Thomas McDonald is Dist. Supt.

The Anderson Rolled Gear Co. is constructing a 50x150-ft. addition to its plant on Berea Rd., Lakewood, Ohio.

The National Tube Co., Pittsburgh, Penn., will construct four 80-ton open-hearth furnaces and a 40-in. blooming mill at its plant at Lorain, Ohio.

Work will be started about Feb. 1 on the construction of a factory at Marion, Ohio, for the Carbon Steel Post Co. Noted Nov. 4.

The National Motor Vehicle Co. is constructing an addition to its plant at Indianapolis, Ind. Noted Sept. 23.

Plans are being prepared for the construction of a garage at Indianapolis, Ind., for Theodore Manmeyer.

Plans are being prepared for the construction of a garage at Indianapolis, Ind., for W. M. Thompson.

Bids have been received for the construction of a garage at Indianapolis, Ind., for H. H. Wheeler, 1832 North Capitol Ave. Frank B. Hunter, 904 State Life Bldg., Indianapolis, is Arch.

The Chalmers Motor Co. has awarded the contract for the construction of four additions to its plant at Detroit, Mich.

Bids are being received by Allen & Curtis, Arch., for the construction of a garage at Flint, Mich., for G. W. Hubbard.

The contract has been awarded for the construction of a one-story factory at Chicago, Ill., for E. H. Wach Co., manufacturer of engines and machinery. Estimated cost, $35,000.

The contract has been awarded for the construction of a two-story, 100x200-ft. factory at Clearing, Ill., for the Wilson & Bennett Manufacturing Co., manufacturer of sheet metal goods. Estimated cost, $55,000.

The Pfanstiehl Electric Laboratory contemplated the construction of a two-story, 35x130-ft. factory at North Chicago, Ill.

The Four-Wheel Drive Auto Co. contemplated the construction of a one-story factory at Clintonville, Wis.

Bids will be received in the spring for the construction of a two-story, 60x106-ft. factory for the Western Steel and Iron Works at De Pere, Wis.

Preliminary plans are being prepared for the reconstruction of the plant at Madison, Wis., which was recently destroyed by fire with a loss of $100,000, for the French Battery and Carbon Co.

Plans have been prepared for the construction of a two-story, 56x115-ft. garage at Manitowoc, Wis., for William F. Hagen & Co., 713 Jay St.

WEST OF THE MISSISSIPPI

The Cloquet Tie and Post Co. is constructing a plant at Cloquet, Minn., for the manufacture of laths and bolts. Noted Nov. 18.

The contract has been awarded for the construction of a two-story garage for the Auto Case Co., 311 South Main St., Rochester, Minn. Estimated cost, $20,000. Noted Nov. 11 and 18.

The Duluth & Iron Range Railroad Co., will construct new car shops at Two Harbors, Minn.

Fire, Dec. 10 destroyed the plant of the A. Geisel Manufacturing Co., Second and Clark Ave., St. Louis, Mo. (manufacturers of enamel ware and stove implements.) Loss, $250,000.

The Times Square Automobile Co. of New York, Kansas City, Mo., will equip a machine shop and construct a plant at Kansas City.

The Steele Motor Car Co., recently incorporated, will establish a machine shop and garage at St. Louis, Mo.

The contract has been awarded by the W. R. Nelson Estate, 17th and Grand Ave., Kansas City, Mo., for a garage. Estimated cost, $19,000.

Bids are being received by Hellmuth & Hellmuth, Arch., Chemical Bldg., St. Louis, Mo., for two-story garage for J. B. Ihmsen, Portland Pl.

WESTERN STATES

The Western Auto Co. will construct a plant at Bremerton, Wash. C. A. Cally is interested. Noted Dec. 9.

The Seattle Machine Works will construct a plant at Seattle, Wash.

It is reported that the Repeater Trap Co. will construct a plant at Vancouver, Wash.

We have been advised that L. E. Fry will be in the market for lathes, drill, emery and air compressor for a garage and machine shop at Condon, Ore. Noted Nov. 11.

Tool-Room and Other Devices in the Pelton Shop

By Fred H. Colvin

SYNOPSIS—The successful use of pin gages depends on some accurate method of setting to know that they are right. The measuring instrument illustrated has proved a good investment and can be made in any shop. The grinding fixture for grinding inserted reamer blades and buzz-planer knives, the offset boring-mill fixture and the babbitting mandrels are all of interest.

The tool room of the Pelton Water Wheel Co., San Francisco, Calif., has a number of interesting features, the most striking being the measuring machine for pin gages shown in Fig. 1. This consists of a substantial steel bar *A*, carrying the two heads *B* and *C*, and the micrometer head at *D*. Over this is the shaded electric light *F*, with the opening at the bottom of the shield, so as to keep the light out of the operator's eyes and throw it directly on the micrometer graduations. Pin gages are very largely used in the Pelton shop. A number of them are shown at the right of the measuring machine. They are made in lengths of from 9 to 100 in., of two sizes of steel tubing—½ and ⅝ in. These fit each other nicely, hardened-steel ends being used to minimize wear. The method of clamping the two tubes is clearly shown. The clamps are substantial, so as to avoid accidental movement of one tube with relation to the other. On lengths of over 100 in. the tubes are spliced together.

The supports *EE*, mounted on sheet-metal bases which spring around the bar *A*, hold the rods being set or tested and make it easy to use this machine. When not in use, the head *C* is moved down under the swinging cover *G*, which is then lowered to protect both the light and the micrometer head. The table of the decimal equivalents on the cover *G* is very useful in this connection. The use of pin gages—which are set in the tool room from standards, allowance for various kinds of fit being secured by use of the micrometer—has increased the accuracy of the work turned out and practically eliminated all dispute in regard to fits and sizes.

Another interesting tool-room device is the rest shown in Fig. 2, which has been built for grinding inserted reamer blades. One of these blades is shown in position at *A*. It fits into the raised bar behind it and projects slightly over the front edge of the table *B*. The latter swings on the pivot *C* and by means of the cross-feed screw *D* can be moved to give any desired radius to the outside of the reamer blades. By grinding all the blades in this fixed position the required clearance can be given with the assurance that the blades will all be alike. Vertical movement is obtained by means of the handwheel *F*, while the square guide *E* holds the table steadily in position.

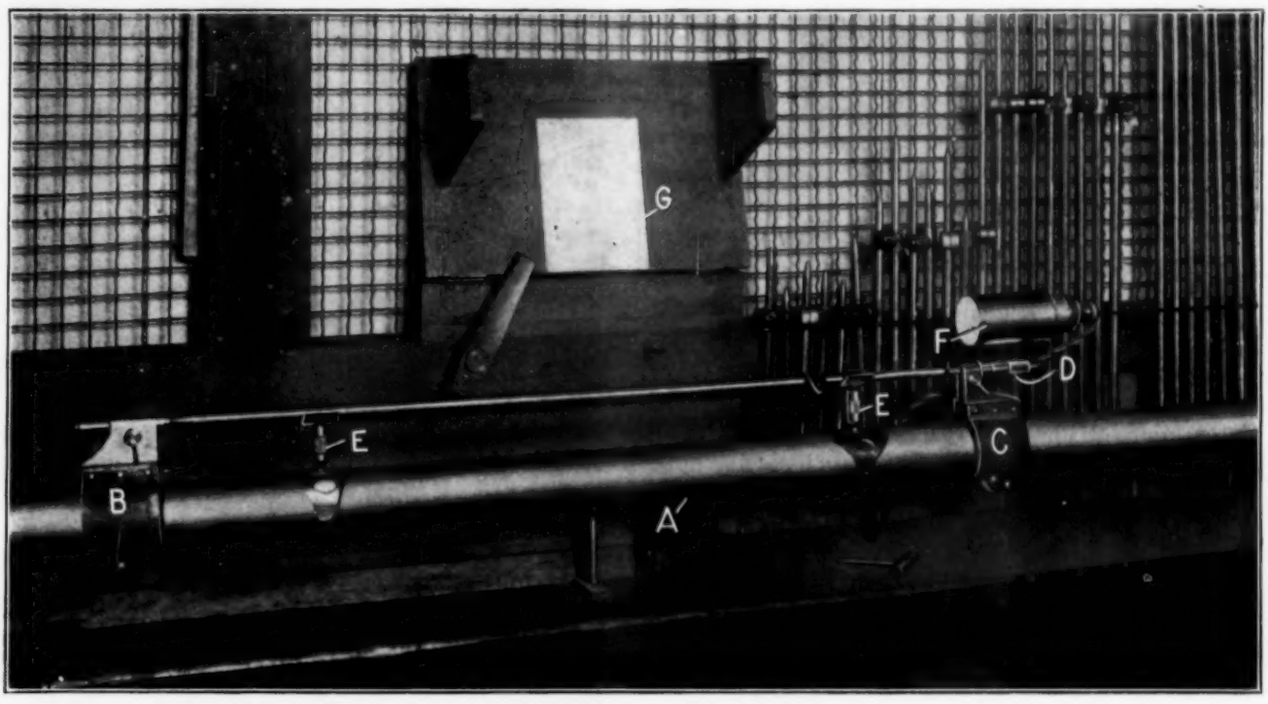


FIG. 1. MEASURING MACHINE FOR SETTING STANDARD PIN GAGES

Another grinding fixture is shown in Fig. 3. It is used in grinding the knives of buzz planers. The holder *A* represents the planer head, and the knife *B* is placed in the same relative position that it occupies in the machine. This is then presented to the grinding wheel so that the cutting edge bears the same relation as when mounted in the cutter head itself, and good results are easily secured. The holder *C* permits the grinding fixture to be adjusted in any way that may be desired.

The boring-mill fixture shown in Fig. 4 is for 4-in. pump cylinders. Its main feature is that the chuck or

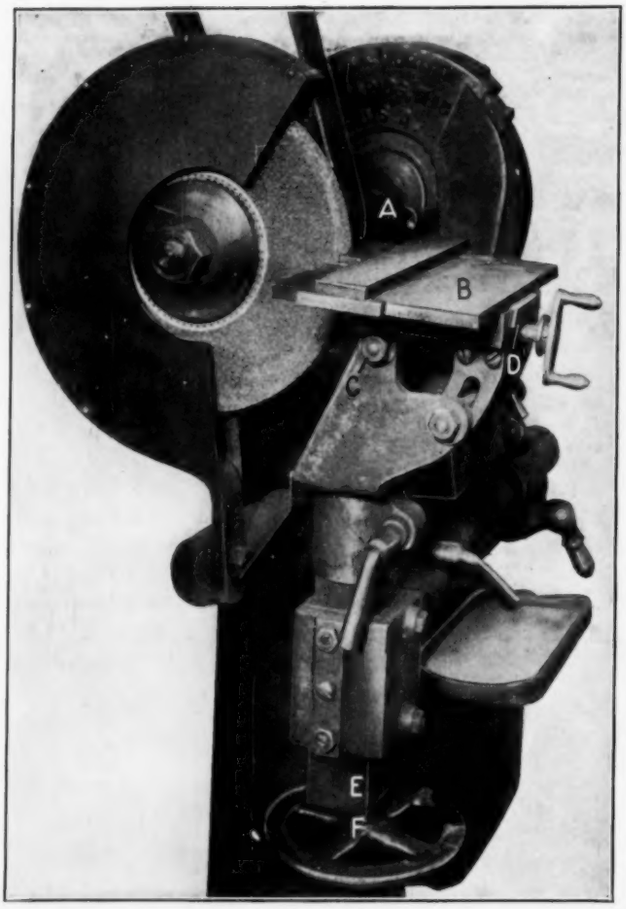


FIG. 2. REST FOR GRINDING INSERTED REAMER BLADES

holding portion *A* can be moved on the base *B* so as to change the position of the cylinder being bored with regard to the center of the boring-mill table. Motion is permitted in one direction only by the key *C*, the different positions being located by the dowel-pin-holes *DD* and the fixture clamped in position by the cap screws *E*. The small jack-screws *F* around the inner edge of the fixture allow positioning of the cylinder casting.

A drilling jig for making slots at different points in round bars is shown in Fig. 5. The bar to be slotted, represented by the mandrel shown, is laid in the V of the base or body *A* and held by the strap *B*. The drilling

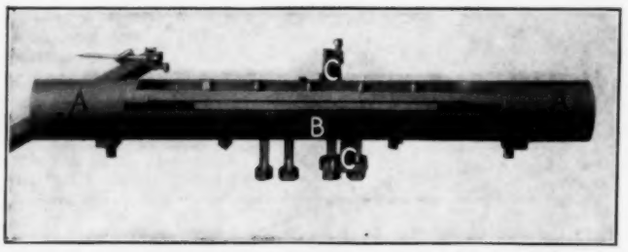


FIG. 3. FIXTURE FOR GRINDING BUZZ PLANER KNIVES

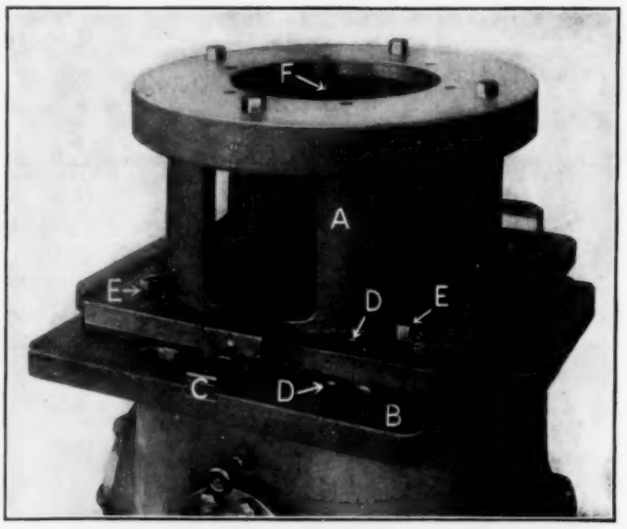


FIG. 4. BORING-MILL FIXTURE FOR 4-IN. PUMP CYLINDER

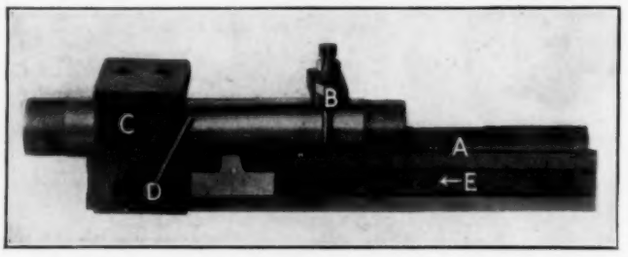


FIG. 5. DRILL JIG FOR SLOTTING HOLES AND CUTTING KEYWAYS IN SHAFTS

bushings are held in the angle *C*, which is adjustable by means of the cap screw *D*. This allows the bushing to be shifted so as to drill holes close together and leave

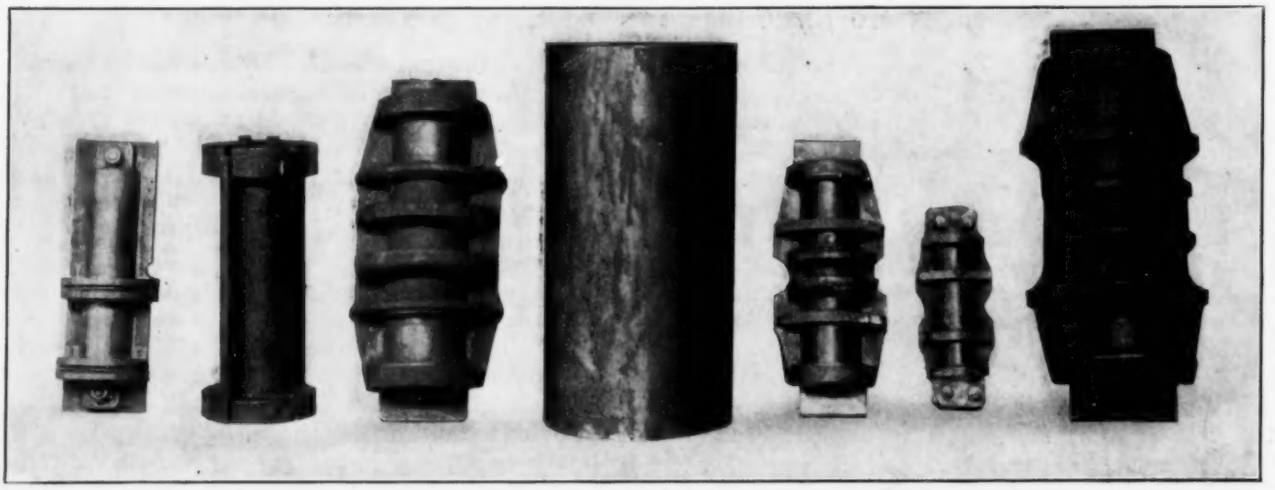


FIG. 6 VARIOUS TYPES OF MANDRELS USED FOR BABBITTING BEARINGS

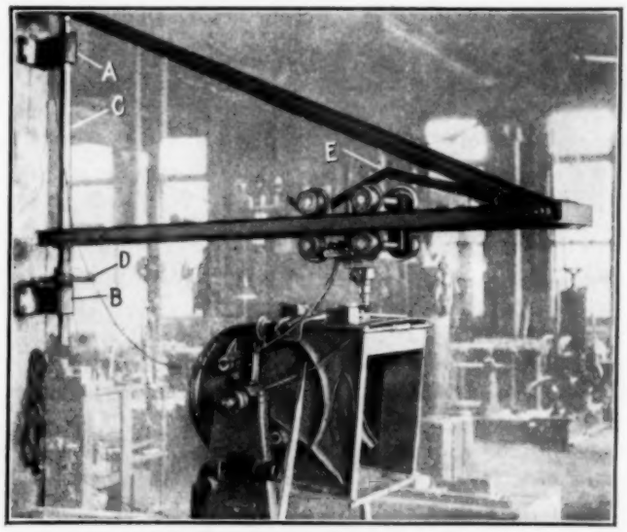
but little metal to be cut out between the holes. The bushing plate *C* can also be shifted to fit in the hole *E* and locate a keyway in a different position.

Much time is saved in the Pelton shop by using first-class mandrels for babbitting bearings. A group of these is shown in Fig. 6. They are carefully made and not only give the sizes desired but also the core for the oil rings when they are to be used, and in this way prevent a lot of work in fitting up. The Pelton Water Wheel Co. considers these mandrels an excellent investment.

A Home-Made Electric Radial Drilling Machine

By Ethan Viall

A comparatively simple and easily made mechanical device often proves a surprise when the results obtained from its use are compared with those of former methods. Eighty-eight rivet holes, 44 in each head, have to be drilled in the dough mixers made by the Triumph Manufacturing Co., Cincinnati, Ohio, in order to attach the sheet-metal shell to the cast-iron ends. For some time these holes were drilled by simply clamping the sheet-metal shell in place, punch-marking the holes and then drilling with an electric breast drill. Owing to the radial position of part of the holes and the size of the pieces, the workman had to change his position continually, and the body leverage needed was exceedingly tiresome. Unsteady holding, slipping and other faults caused the



AN ELECTRIC RADIAL DRILLING MACHINE

breakage of many drills, as the holes drilled were small. Finally, the radial device shown was evolved, with results that are satisfactory. Two cast-iron brackets *A* and *B* are bolted solidly to one of the shop posts. Through holes bored in these is placed an upright piece of shaft *C*. This shaft is threaded on the lower end and a handwheel *D* is run on it for the purpose of elevating or lowering when needed. To the upright shaft a triangular frame made of structural iron is attached. The tracks for the truck are made of 3-in. channels 10 ft. in length, placed 12 in. apart. The truck has eight flanged wheels, 4 in. in diameter, placed four on each side, so that two of each set ride on the top of the channel on that side and two run below. No device is needed to lock the truck wheels to the tracks, as the mere weight holds them in place while drilling the $\frac{3}{16}$-in. holes for the rivets. The electric drill used is one of a regular type made by the Standard Electrical Tool Co., to the sides of which slides have been attached. These slides work in ways or guides on the truck. A link at the top connects the drill to a feeding lever *E*. The weight of the drill is a little more than counterbalanced by means of a spring, so that the drill will always return to the upper end of the guides when released. The extra counterbalance is slight and the feeding lever long enough, so that the workman drills the holes with little effort. The slides are made long enough to give the drill a maximum stroke of about 5 in. Where this is not sufficient to reach the work properly, the handwheel *D* is used to adjust the height. With a dough mixer mounted in its own bearings, as shown, it can easily be rotated and the drill truck run along the track or the radial arm swung around so as to bring the drill almost instantly into the position wanted. When ready, the workman pulls down on the feeding lever, and the holes are drilled nearly as rapidly as if punched.

Working Monel Metal in the Screw Machine

By R. M. Earl

In modern times, when one meets with an obstacle out of the ordinary, it is only natural to look for precedent, an explanation or data pertaining to the subject in hand. In the good old days, a mechanic that happened to strike a snag would either go around it or, if that was not feasible, would work out a more or less correct solution by the cut-and-try method, keeping all knowledge and data (which he retained mentally) gained thereby to himself, to be used thenceforth as a secret trade formula, or trade secret. Sometimes this was his sole stock in trade.

Today it is different; 90 per cent. of the manufacturing of the present is based upon hard-and-fast rules, formulas and methods, standardized from data and facts compiled by patient men working scientifically to solve knotty problems for the benefit of humanity. Coming upon a hard problem, the mechanic of today has usually but to look up the solution in the library formed by back numbers of the *American Machinist*, its handbooks or one of the other better class of reference books on the subject, though one is sometimes completely stumped. I have looked in vain for data on working monel metal.

Did you ever try working monel metal of small cross-section with form tools on a screw machine, and get anything near satisfactory results? Here is how I solved this problem:

The piece was an odd and complicated shape about 1 in. long, requiring eight forming tools and two box tools. It was to be made from $\frac{3}{16}$ in. round monel-metal rod. The automatic screw machine bought especially for this purpose came already crammed and tooled up for the job, with the necessary countershaft, spindle speeds and correct feeds, instructions as to oiling, etc., and to use high-grade mineral lard oil as a cutting lubricant.

Everything was carried out as directed, and of course we thought that all we had to do was to load up and go ahead. But we were doomed to disappointment: the metal galled every rest and guide and burned the high-speed steel tools. We tried the whole range of speeds and

feeds, up one way and down the other, backward, forward and crosswise, but all to no avail.

Then we tried brass and could easily maintain a high production rate, but the monel metal was very different. We had about lost patience and were ready to abandon the work, when the superintendent, a very patient man of wide and varied experience, suggested trying pulverized sulphur in the cutting compound.

So we tried sulphur, adding a little at a time, and keeping account by weight of the proportions used, also the speeds and feeds. The good effects of the sulphur were apparent at once in so far as the tools were concerned, but the bushings and rests would still gall at high or medium speeds. To overcome this, rests similar to a spinners' lathe tailstock were made, the rest rotating with the work, supported by ball bearings.

After obtaining the highest practicable speeds and feeds and the best sulphur and lard-oil compound, our troubles were over except that the work came from the machine very much tarnished from the chemical action of the sulphur, although this did not impair the quality in the least. The result of our experience may be summed up about as follows: With monel metal $\frac{3}{16}$ in. diameter, speed 1,100 r.p.m., average feed 0.0015 in. per revolution on box tools, 0.0005 in. per revolution on forming tools, the cutting lubricant was 1 part sulphur to 20 parts, by weight, of good-grade mineral lard oil.

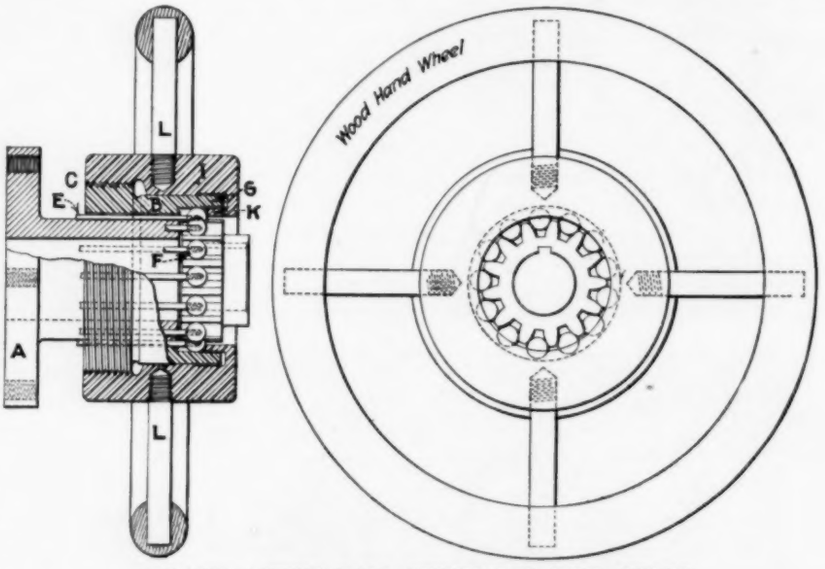
The tools must not have undue rake, but must be kept very sharp at all times or poor or worthless work will result.

What made us feel that our troubles were fully compensated for was the receipt of a letter from the machine builder stating that, had they fully understood the nature of the job, they would have had to refuse the contract in order to avoid any unjust criticism.

The only disadvantage of this chuck is that it can be used only for gears with the same number of teeth and pitch. It is, however, inexpensive, and the increased production and positive accuracy make it very economical.

This chuck is an evolution. With only three pins in my cast-iron chuck good results were obtained when all conditions were perfect; but trouble started when there was any variation in the teeth, caused either by distortion in heat treating, carelessness on the part of the gear cutter operator or when the pitch diameter varies a few thousandths. When using six or more pins of the same size better results are obtained, but chucking time is increased.

This is a tool-steel chuck, with a ball in every tooth space of the gear, and holds the gear firmly and accurately. The chuck is secured firmly to the faceplate and trued up to run perfectly, and all my troubles with eccentric gears have disappeared.



A RAPID-ACTING BALL CHUCK FOR SPUR GEARS

The chuck body and hood are made of tool steel hardened and ground. The flange *A* is tapped out to bolt on the faceplate, which is bored a few thousandths larger than the flange; cup *B* is ground to some standard size and must be straight and round. The thread at *C*, for tightening the back hood, is 1 in. long and 8 pitch. The balls are $\frac{3}{8}$ in., annealed, drilled and tapped $\frac{1}{8}$x$\frac{1}{4}$ in. deep, then are rehardened and a piece of $\frac{1}{8}$-in. rod *E* 2 in. long is screwed into each ball. These rods act as retainers for the balls and keep them in position. A small coil spring *F* helps to release the gear.

The mouth of the cup is ground to a 3-deg. taper and forms the contact point of the outside diameter of the circle of balls. The surface *I* is a ground bearing in the hood and must be a very close sliding fit on *B*. The nose *K* in the hood is made long enough to take any variation in gear sizes and is large enough to clear the outside diameter of gear by $\frac{1}{32}$ in. It is recessed all around to clear *G* and bears against the circle of balls. This nose must be ground perfectly true with *I*, to insure keeping all the balls in a straight line while being tightened. Spokes *L* carry a handwheel, which is convenient for the operator, as it takes but a half turn to either tighten or release the gear.

Ball Chuck for Spur Gears

By John Kunsler

I have been in the grinding game for a long time. My experience includes a thorough acquaintance with nearly all the ordinary grinding fixtures and methods. Gear work has been my line for the past three years, and I have constantly had trouble with grinding gear holes concentric with the pitch line.

I have tried several methods, among them the solid ring and rollers or pins, also a cast-iron chuck and pins, the chuck being made up on the same principle as a draw-in collet. This chuck is fairly good, but a little slow to operate and not quite reliable enough, as my eccentric gears—eccentric more than 0.002 in.—were nearly 10 per cent.

I recently designed a new grinding chuck and have ground more than 5,000 gears in it, all within 0.001 in. of being concentric. These gears were ground in almost one-half the usual time and with no extra effort on the part of the operator. The principle on which the chuck operates is made clear in the illustration.

Small-Shop Reflections

By John H. Van Deventer

SYNOPSIS—In approaching the time for New Year's resolutions, why not resolve to put your small shop into the class of eminently successful ones? It can be done, and the reflections in this article, in which are crystallized the essence of the 50 articles which have preceded it, will help you to do it.

The strongest proof that small shops can succeed is the fact that they do. Eighty per cent. of American manufacturing plants are small shops, each employing less than 20 wage earners.

The selection of work in the small shop is just as important to its ultimate success as a man's choice of a career. It crystallizes into specializing at what one is best able to do. It's never too late to begin. A shop doesn't get old as quickly as a man, and many successful men have spent half of their lives groping about for the right way. Small shops which specialize are the ones that are making the most profit. The successful shop does the thing it can do best in the best way it can do it.

While there is sometimes glory to be gained by being a pioneer, there is not a great deal of money in it. Changes may be divided into two classes—those that you want to make and those that you are forced to make. There are usually enough of the latter in the average shop without making too many of the former.

The little shop that is struggling to get a grip will not at first be able to do more than pay the interest on its debts. Sooner or later, however, money must be set aside for the purchase of new equipment, for otherwise the value of the initial investment will shrink and there will be nothing available to bring it back to its original proportions.

Every time you overlook an item of manufacturing expense you make the customer a present of actual money and are helping to make small shops unprofitable investments.

Advantages which come without being sought are as likely to disappear quickly. Anyone who figures on these things is a gambler, and the small shop cannot afford to shelter one who pursues this pastime during business hours. But the man who can do good work at a low price and make a profit is entitled to all the work he can handle and to his competitors' respect into the bargain, provided he does it through skill and originality and not through fictitious or unfair advantages.

Hairsplitting is an expensive luxury for the small shop. Fine subdivision increases the chance of error. Many a man lets $14 worth of profits walk out of the front door and spends $7 worth of time while trying to stop a 15c. leak in some dark corner.

In a restaurant a big French name often hides a small baked potato, but in the shop it's of no use to keep a fancy record of castings on hand when you can count them in half the time. Don't put into your shop a machine or system that you cannot use. Don't buy a complicated machine or use a complicated method where a simple one will answer.

The conclusions made from the cost per hour or from an expense rate of so many cents per dollar of labor must be qualified by the quantity of work produced in that hour or by the value of the labor bought with that dollar. Overlooking such things is cultivating an appetite for forms and an indigestion for facts.

Fifty per cent. of the time spent in taking shop inventories is thrown away, for the average shop owner does not know why he wants it, how to get it or how to use it. A good label for the small-shop man to paste in his hat is, "Know what you want and why you want it."

Profit must be expressed either in connection with a period of time or with a definite quantity. The fact that a profit of $10,000 has been made is cheering news, especially if you have made it; but Bradstreet's representative wants to know if this is the result of a lifetime or one year or a single job, before he will write it down in his album.

The additional cost necessary to obtain a little better quality is more than offset by the amount a customer is willing to pay for the machine. A customer's first order may come on price, but his next five or six are apt to be based on quality.

One can tell at a glance whether a sense of order is present or sadly lacking in the small shop. The credit man takes it into account when he is sizing you up. The prospective customer who looks you over is influenced by its presence or absence. Your own personal standard is unconsciously affected by the degree of order existing in your shop, and the possibility of the growth of your shop is absolutely limited by it.

The Appreciation of Small Equipment

Don't buy a $2\ ^{7}/_{64}$-in. reamer if you use it only two or three times a year. It will eat up enough interest while lying on the shelf to more than pay for the extra light cuts in the lathe. But if this dimension is found to recur 50 times a year, it should be considered necessary to have one of these reamers and also to establish a standard for this dimension and to have the necessary gages wherewith to measure it.

Give thought to the question of balance. Have you a No. 10 toolroom and a No. 3 shop? If so, it will be as uncomfortable as No. 10 shoes on No. 3 feet. On the other hand a No. 3 toolroom on a No. 10 shop will produce corns rather than profits.

The question for the boss to ask is not "Will it save time?" but "Will it pay?"

Jigs take a job away from expensive machines and put it on lighter and cheaper ones, saving not only time and pay-rate but also wear and tear on the more expensive machines. A machine tool that is on the verge of going to pieces is as safe a bet as a racehorse with a wooden leg. You cannot make money out of either of them, no matter how much coaxing or doping is done.

You must cultivate the art of seeing the gold underneath the cast iron and the steel, and must appreciate the need of caring for jigs and small tools. When you spend $50 for a jig, spend 50c. on its insurance. A wooden

box will keep the edge on a reamer blade much more cheaply than it can be put back with a grinder.

Strive for efficiency by all means, but first find out what it is.

Get a pair of spectacles that will enable you to see the individual actions and the intervals instead of seeing the job as a whole. It isn't so much the timing of lost intervals that counts as it is the brains and reasoning that are employed to reduce them.

Time study is merely a useful tool—a microscope, if you will, that magnifies and reveals the hidden structure of your work. Here is an instrument that will measure more accurately than the finest micrometer; that will give you a more intimate knowledge of your work than a shelf of textbooks; that will effect more saving, if properly used, than a shop filled with new equipment.

If half the fuss that has been made about speed had been made about other things that need improving, machine shops would be farther advanced than they are.

The real savings come as a result of systematic effort. A great many shop managers are contented with spasmodic savings. They hit the head when they see it, but it has to stick up a good ways first.

It pays the small-shop owner to purchase his materials on specification and to reject them very promptly when they fall below requirements. Those who do this are respected and receive better treatment.

The question of inspection resolves itself in the long run into "Will it pay?" If it figures exactly even either way, install the inspector, for if he is the right man and you are the right manager the results will exceed expectations.

If you are inclined to be a philanthropist, forget it while installing your pay system. The small-shop man is not the one to demonstrate philanthropy—his money will not last long enough. It is a sordid business to buy the regard of your employees instead of earning it, which is virtually what an employer does who permits sentimental consideration to run away with commonsense.

The secret of success in operating either daywork or piecework is two know how the job should be done and how long it should take and then make the reward in proportion to the results.

Commercial Rating of a Good Example

Beware of the arbitrary piece-price or standard-time setter. He is as dangerous as a firecracker in a gun-powder factory.

In your shop there are men whose value you do not measure strictly by their output. There are men who set good examples, and a good example, while it is not rated commercially, is still a valuable thing to have around.

The inexorable law of averages says that the small-shop man will annually produce goods of the selling value of $1,950, and in so doing will add annually $1,270 to the value of raw material. One of the first maxims of manufacturing is to multiply profits by profitably employing others.

The average repair shop needs a man who can draw, but more often a man who can draw checks than pictures. As long as he can convey what he wishes to the men, the small-shop owner who is his own designer does not need to be a skilled draftsman.

The average shop as it grows accumulates many different styles and designs. Nothing is ever thrown out or discarded. Patterns and tools and junk accumulate until the greater part of the plant is a graveyard, boasting at infrequent intervals of single resurrections. When you have work of this kind that is nine-tenths dead, it will be charity to put it out of its misery.

After the idle stock has been moved back and forth during a few years it has accumulated enough expense for storage, handling and general nuisance to convert it into bronze instead of cast iron. Keep this process up long enough, and you will change it into gold, in cost value at least. Look for the material deadheads more closely than for the human ones, for they are harder to detect.

Orders are not issued for the benefit of the man who gets them so much as for the man who issues them. Nine-tenths of the value of a written order is that it serves a memorandum. Write down what you are likely to forget or what your man is likely to misunderstand.

Beers, Belts, Dead Ones and Dope

What a man does and eats at home affects his shop life most strongly. Seven beers the night before are as bad as an unguarded elevator opening. An indigestible meal produces worse effects than the absence of lights at the top of a stairway.

Line-shaft friction is one of the many little wastes that go up in heat (and sometimes in smoke) without doing anyone any good. The loss from such causes is more serious in the small shops than in the large ones, for the reason that proportionally more power per man is employed.

The shop in which the locations of machines are never changed is a dead one.

Before you put up a pulley, make sure that it is properly balanced. Conclusive evidence that this is neglected in most shops can be had by standing upon an upper floor and feeling the vibration due to unbalanced pulleys.

The efficiency of leather belts is low in the small shop. Inefficiency does not always show up in the form of trouble, but it always makes its tooth-mark on the expense ledger. It pays to buy, install and properly care for small-shop belts.

The shop superintendent sometimes looks upon the dope pot as a substitute for more intelligent work, and this may help to account for high belt-expense rates in some shops. Clean and dress your belts every six months at least.

The willingness to take a chance, if done with judgment, forms a large part of the basis of American prosperity. It pays to take a chance where the loss, if any, is certain to be small, and the gain, if any, is likely to be large. Choosing a machine tool by its weight is as senseless as selecting a phonograph record by its smell.

Give a dog teeth if you want it to bite, and give the lathe a rigid tool post if you wish it to eat iron. Springy tools and fixtures do more to cut profits than any other small-shop enemies, while rigidity and balanced cutting pressure will do much to increase them.

You can figure planer profits very closely by measuring between the top of the work and the bottom of the crossrail. The greater this distance the less the profit, because the rigidity will be reduced.

Machine-tool foundations should be made of a mixture of four elements—sand, stone, cement and brains.

One is likely to regard the planer as a heavy chunk of metal capable of standing abuse. There would be a much

heavier mortality rate among us human beings if we wore our vital organs outside our ribs in as exposed a position as are planer V's.

Six spindles with a $2-a-day operator against one spindle run by a $4-a-day mechanic looks good to most shop owners.

Jigs will make a poor, old decrepit machine that can't bore within an eighth of an inch turn out work to the thousandths limit.

It takes more brains and ingenuity to make a cheap jig good enough for the job than it does to produce a high-grade specimen of the toolmaker's art.

Nine out of ten bad babbitt bearings are due to overheating or too slow pouring.

You, Mr. Small-Shop Man, have a certain amount of energy in your makeup. This is the force that gets behind your little red wagon and pushes it over the hill of prosperity. You cannot stop to pick daisies along the roadside and expect to reach the summit before the night comes. Whatever will help you conserve your energy so that you can apply it to your real product is worth considering as a help. To pass up the small aids because they are small is a mistake.

Remember this definition of success: Make friends of your customers through the quality of your work, friends of your workmen through the quality of your treatment and as much money as you can without losing the pleasure of living.

Jigs Used on Magneto Parts and a Motor Detail

By Robert Mawson

SYNOPSIS—The method used when boring the field frames is one in which the smallest amount of special equipment is required, yet the parts produced are accurate. A multiple sawing fixture for making segment bars employs two cams operated with a lever to force and hold the bar in position. Simple jigs are also shown, employing fixed locating surfaces, which are possible when the castings used are of an interchangeable nature. These tools are utilized in a small shop when the production is not large, yet where the use of special tools has been found to be indispensable.

Some of the methods used by the Henricks Magneto and Electric Co., Indianapolis, Ind., have been shown in a previous article. Here are illustrated and described others.

In Fig. 1 is shown the method employed when boring field frames used on starting and lighting systems. The frame is located on the fixture *A* by dowels and held against the finished plate *B* with the strap *C* and bolts. The frame is then fed along the revolving cutter bar *D* and the air gap machined. A recess is machined at the forward end of the frame with the cutter *E*.

The various cutters used in the bar are of the one-point type, being held with setscrews as shown. The average time required for boring a field frame by this method is 45 min.

When drilling the battery brackets the jig shown in Figs. 2 and 2-A is used.

The rough casting is located in the jig with a stop pin, shown in Fig. 2-A, and is then held in position with the clamp *A*.

The boss on the arm *B* rests on an adjustable support to assist in holding it against the machining strains.

Three ½-in. holes are then drilled in the bracket, the tool being guided through the bushings *C*. It will be observed that feet are provided on the jig, so that it will rest squarely when drilling from the two sides.

The fixture used when sawing up the commutator segment bars is shown in Figs. 3 and 3-A.

The bar of copper, which is made of the correct contour, is pushed into the slot *A* against the stop *B*. The handle *C*, which operates two cams *D*, is then pushed down, thus holding the bar in position. The fixture is located by the tongue *E* and held to the machine table in the usual manner.

The saw set-up consists of eight 4-in. diameter by 3/64-in. thick saws accurately spaced.

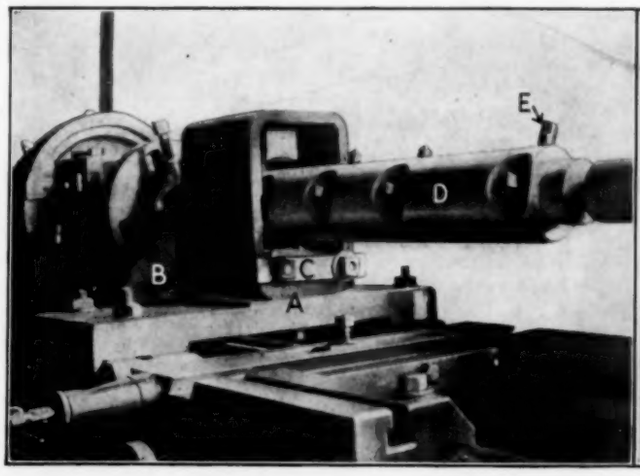


FIG. 1. BORING THE FIELD FRAME

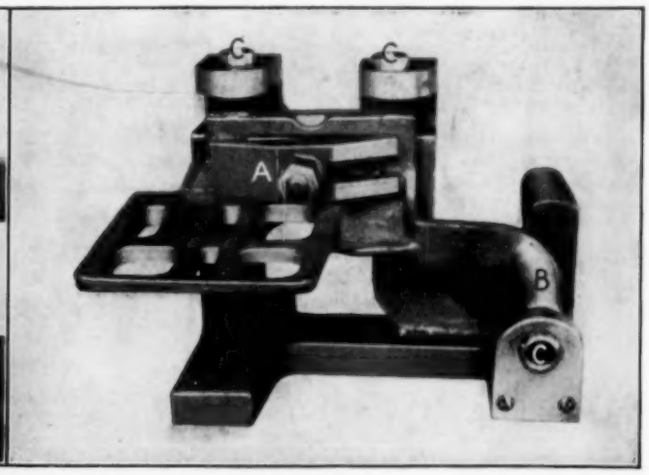
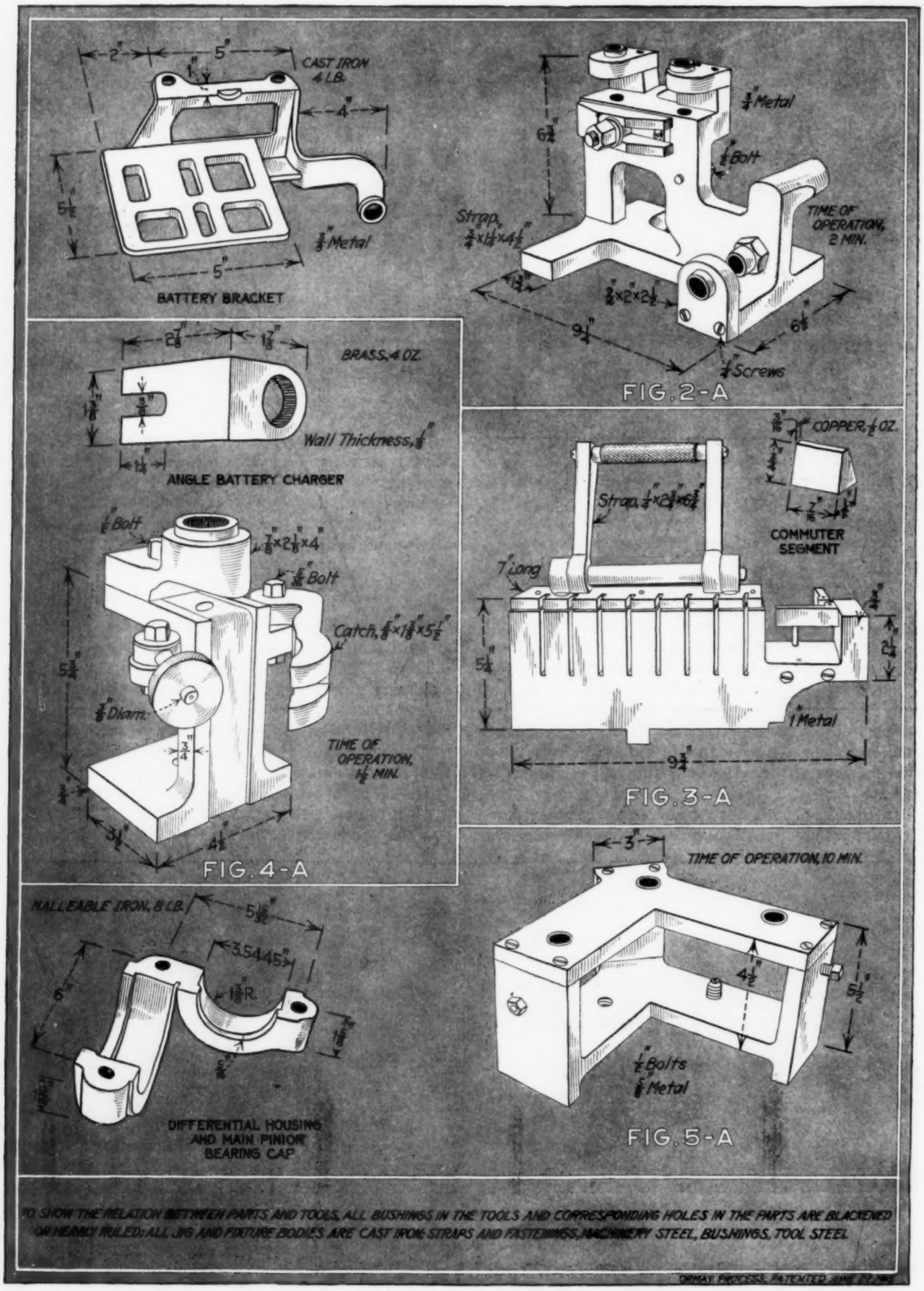


FIG. 2. DRILL JIG FOR BATTERY BRACKET



DETAILS OF JIGS USED IN MACHINING MAGNETO PARTS AND A MOTOR DETAIL

As the space between the last slot and the locating stop is equal to the distance between two slots, eight segments are made at one operation.

The saws operate at 800 r.p.m. with a feed of 0.004 in. per revolution.

The jig used when drilling cut-out angles for the battery charger is shown in Figs. 4 and 4-A. The part is

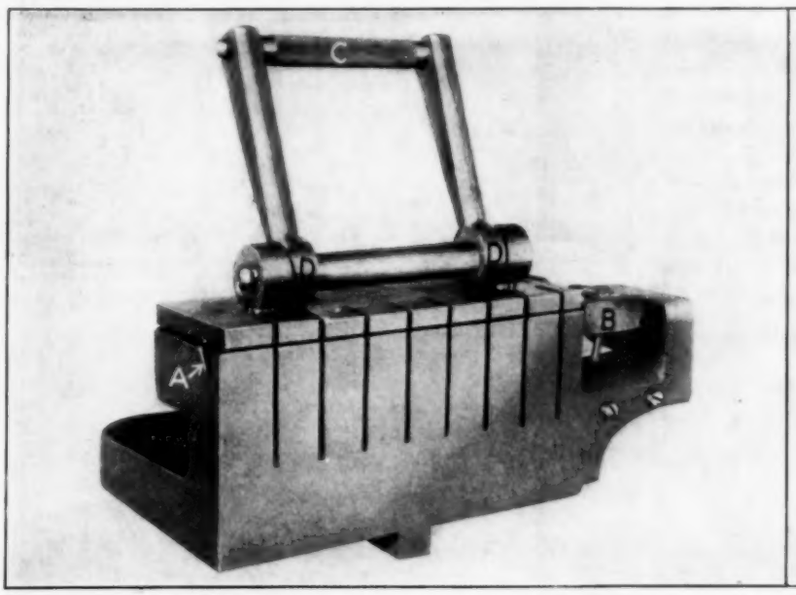


FIG. 3. SAWING FIXTURE FOR SEGMENTS

FIG. 4. JIG FOR CUTOUT ANGLE

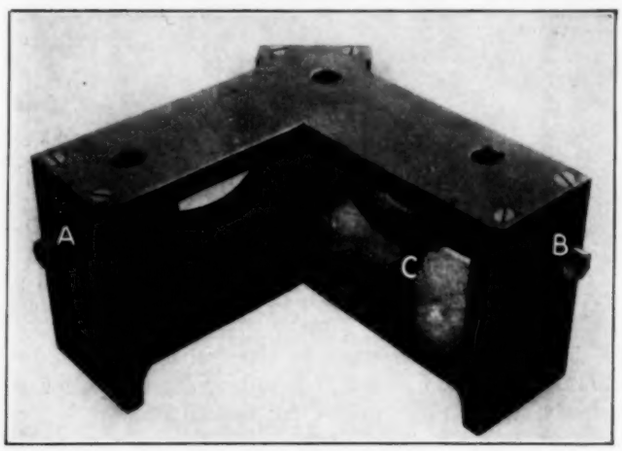


FIG. 5. DRILL JIG FOR BEARING CAPS

placed in the jig fitting in the recess as shown and resting on the flange of the jig. The clamp *A* is then swung back and held with the hook bolt and knurled-nut *B*. A $\frac{13}{32}$-in. hole is then drilled and the face machined and counterbored, using the combination tool *C*, which is guided through the bushing *D*.

In Figs. 5 and 5-A is shown the jig employed by the Seagrave Co., Columbus, Ohio, in drilling the differential housing and main pinion bearing caps used on fire-engine power units.

The casting, which has been machined on the joint surfaces, is placed on the jig, which is slid against a stop surface at the rear. It is forced against an adjustable screw at the end *A* with the screw *B*.

Two screws as *C* are then tightened to force the casting against the upper surface of the jig. Three 49/64-in. holes are then drilled in the part.

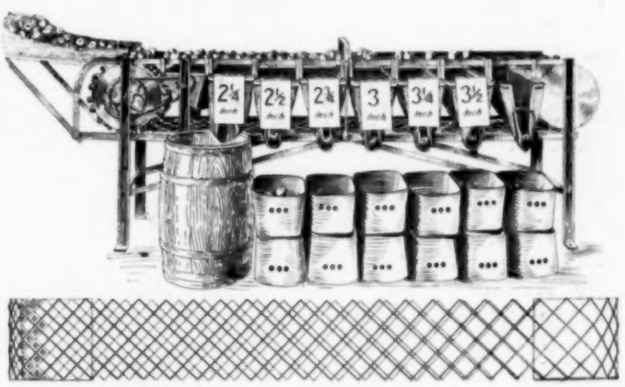
Clever Sorting Device of Simple Design

By John E. Sweet

A friend from Rochester who was visiting me called my attention to the fruit-grading machine shown in the illustration. Its cleverness interested me and I sent word to the inventor, who is a farmer, that I thought a good mechanic had been spoiled to make a farmer—though it is said he is a good farmer.

The cute thing about it is the arrangement whereby the holes in the chain through which the fruit is to pass grow larger and larger as the traveling chains move along.

There are two chains, made of bent wires, which extend across the grader. These wires are linked together so as to form holes about 4 in. square. In the outer belt



MECHANICAL SORTING DEVICE

the links are slightly longer than those in the inner one, as there is one more row of holes in the inner than in the outer belt, and hence as the chains pass over the starting drum the wires mismatch. The holes are only 2 in. square; but as the chains pass along, one of the four holes constantly becomes larger and larger until it reaches the other drum, when it is 4 in. square. The idea is shown clearly in the lower illustration.

A Special Milling Fixture for a Tapered Slot

By E. V. Allen

In making an expansion locking device employed on some of its machines the Cincinnati-Bickford Tool Co., Cincinnati, Ohio, has resorted to the use of a special milling fixture for producing a tapered slot in certain parts. One of these parts, with a tapered slot milled in it, is shown in Fig. 1. This piece is of steel and in milling is placed as shown at *A*, Fig. 2. The cutter is a round-toothed stocking cutter. The base of the fixture is bolted securely to the miller table. The upper part *B* of the fixture is fastened to the base by means of a pivot directly under the milling cutter. This pivoted member carries a slide *C*, which is operated by means of handwheel *D* and screw *E*. The work is clamped to a holder on top of the slide. If the slide and pivoted member were placed in line with the miller table, and the handwheel turned, the cut made in the work would be merely a round-bottomed slot of the same width as the cutter.

However, if the pivoted member is gradually swung over as the handwheel is turned, the result will be a slot narrow at the start and wider at the other end, the width depending on the distance the pivoted member is swung over, within certain limits, and also on the size of the cutter. In order to produce a certain sized slot in this case, a cam is placed at *F*, against which a guide roller *G* is pressed by means of a cord *H*, which is weighted on the end opposite to the one attached to the pivoted member. In operation the roll follows the outline of the cam as the handwheel is turned to run the slide forward. The slot produced is narrow at one end and wider at the other, but it is not symmetrical, as it flares more on one side. To balance the cut and produce a symmetrical and evenly tapered slot, the lever *I*, after the roller has been run out to the end of the cam on which it is riding, is swung in as shown in Fig. 3. The swinging in of the lever *I* brings another cam slide into position, as shown at *J*. This has the same slope as the first cam, but in an opposite direction. The slide is now run back by reversing the motion of the handwheel *D*, and the weighted cord keeps the roller in contact with the cam *J* as it recedes. The reversal of movement thus obtained causes the cutter to flare out the wide end of the slot to match that made by the first cut, so that in running the work forward and back under the cutter a perfectly symmetrical tapered slot is produced.

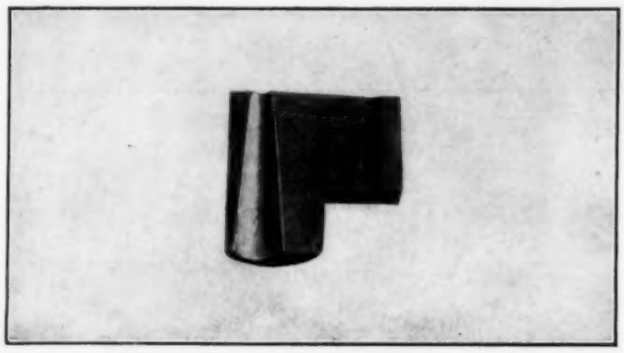


FIG. 1. PIECE WITH TAPERED MILLED SLOT

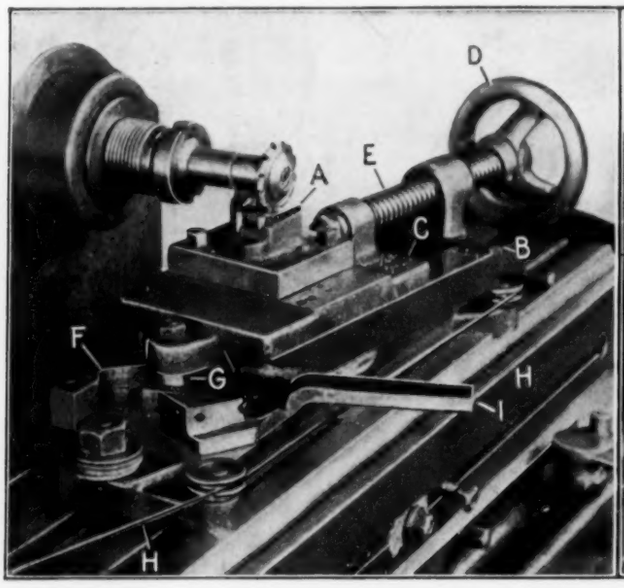


FIG. 2. FIXTURE IN FORWARD MILLING POSITION

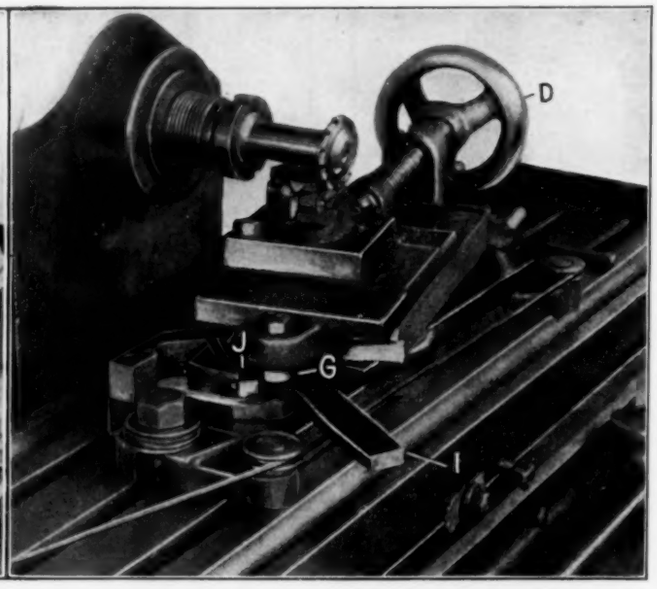


FIG. 3. FIXTURE IN SECOND CUTTING POSITION

Use of Molding Machines—In a paper presented to the International Engineering Congress, dealing with recent advances in founding, the two common methods of making molds were reviewed. One of these comprises what is called "bedding in." This demands that the pattern be placed in the position in which its mold will be cast, and sand is rammed in, under and around it. The second system, called "rolling over," or "turning over," requires the pattern to be placed the reverse way, and the sand is rammed around and on top of it, after which the pattern, the sand and flask are "rolled over" to bring the mold into the position in which it will generally be cast. Molding machines are chiefly of practical use in "rolling-over" work, which comprises on an average fully 80 per cent. of the combined production of all foundries. There are four distinct steps in the use of molding machines for "roll-over" work—first, the ramming of the sand; second, the "rolling over" of the "nowel"; third, the ramming of the cope; fourth, the drawing of the pattern. The "nowel" is the lower body of a mold, while the "cope" is the upper section, and between the two exists the joint, which when the cope is rammed on and taken off from the nowel permits the pattern to be withdrawn from its mold. The nowel and cope are generally rammed independently on the machine. Again, the "rolling over" of nowels or copes, also drawing of the patterns, may be done by following the practice which obtained before the introduction of molding machines.

System of Factory Dispatching

By C. B. Auel*

SYNOPSIS—This system possesses five advantages: Starting work on schedule time and continuing it without delay; giving a close knowledge of production; determining readily the efficiency of machines and operations; determining the capacity of the department in tools and men; relieving the foremen of clerical and routine work. The few necessary forms are shown and a complete description is given of the operation of the dispatch board.

The majority of orders, particularly if of any size or involving one or more special items, are generally preceded by inquiries from the prospective customers as to times of delivery. In a very small manufacturing concern the duty of making suitable replies usually devolves upon the proprietor himself, while in a rather large concern either the foreman or the superintendent takes over this function, since the proprietor is hardly able to familiarize himself with such details in addition to other and more important matters requiring attention which cannot be delegated so well to others. As the concern increases in size, such work requires the services of several men until finally, in the largest concerns, a regularly organized department is established, known as the production department.

Inquiries as to times of delivery on prospective orders are sent from the sales department to the production department, and it is of the utmost importance that all promises made by this latter department be kept if the orders are subsequently secured. It is accordingly necessary to make a readily available record, so that promises may later be connected with orders. To this end production-estimate cards are issued with the assistance of the various departments interested—engineering, manufacturing, storekeeping, etc.—which cards contain descriptions of the apparatus required, performance, promised times of delivery, names of customers, new and old parts entering into the designs, etc. These cards are then sent to the sales department, which in turn advises the customers.

Upon receipt of an order it is promptly rechecked by the engineering department to make sure that no possible errors have crept in and that contract requirements can be properly fulfilled by the apparatus, after which a general order is entered, listing all of the items purchased by the customer. This general order is forwarded to the storekeeping department and scrutinized there, so-called shop or stock orders being entered on the manufacturing departments for such items as require to be built in the works.

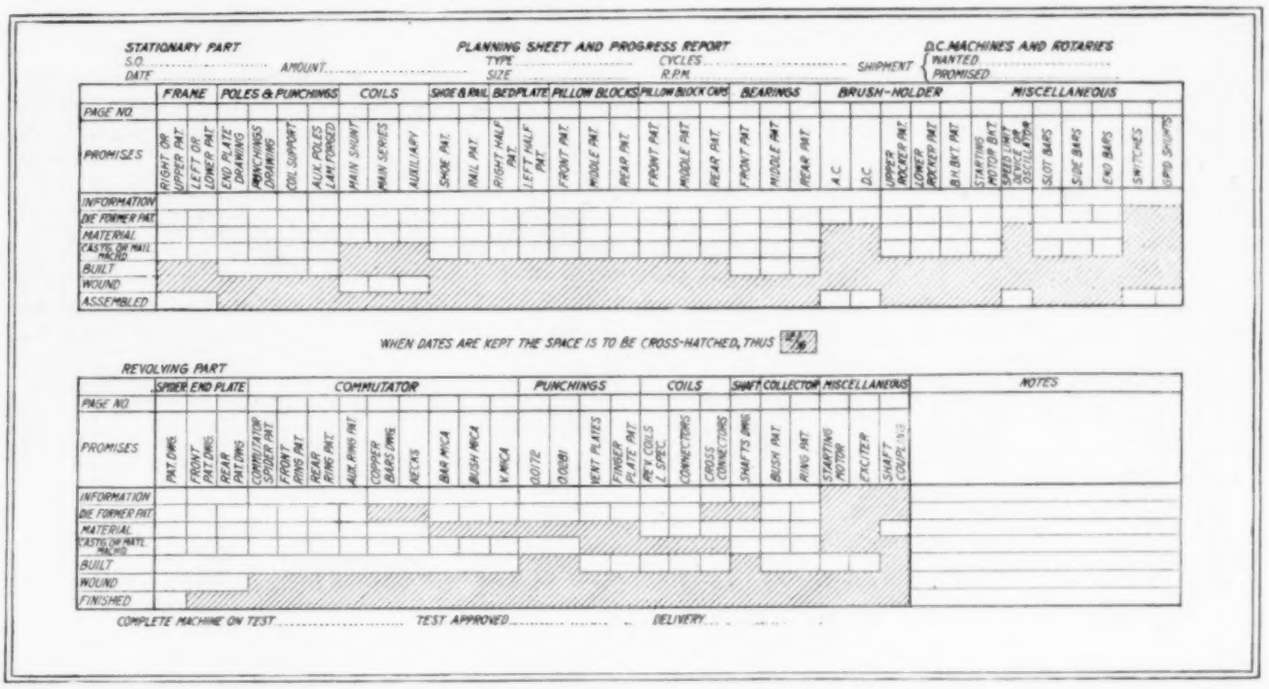


FIG. 1. SPECIMEN PLANNING SHEET AND PROGRESS REPORT

In order to manufacture economically, work in the factory must be planned or laid out so that it can be brought through to the best advantage both as to cost and time. To accomplish this a system must be followed which is not only flexible but which is also devoid of unnecessary features. There is no such thing as a one best universal manufacturing system, but there may be many equally good when confined to certain specific lines. In all systems worthy of the name, however, there are several matters in common, namely: Planning or laying out the work (not including designing); ordering the material; dispatching the work; costing the order.

The details of these will naturally vary with the apparatus or material manufactured. The simpler it is in itself

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or the more standardized it has become, the simpler and easier will be the production system in connection with it; and conversely, the greater the complexity or the more special the design, the more elaborate will be the production system required. As the latter is the harder to control properly, it will be better to describe a system applicable to such a condition, involving, say, a customer's or-

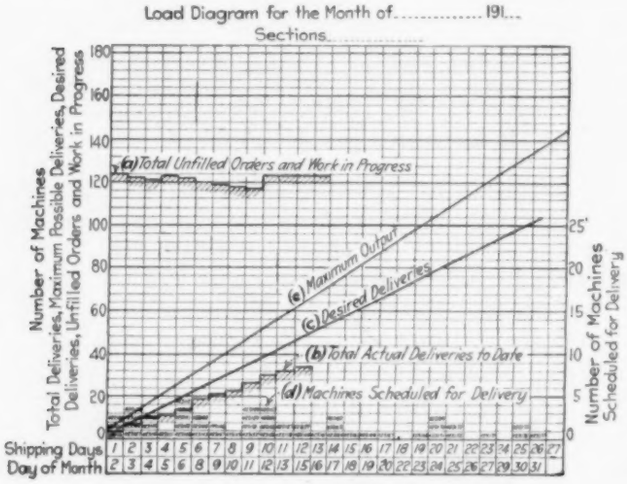

Load Diagram for the Month of..... 191...
Sections.....
Number of Machines
Total Deliveries, Maximum Possible Deliveries, Desired Deliveries, Unfilled Orders and Work in Progress
(a) Total Unfilled Orders and Work in Progress
(e) Maximum Output
(c) Desired Deliveries
(b) Total Actual Deliveries to Date
(d) Machines Scheduled for Delivery
Number of Machines Scheduled for Delivery
Shipping Days
Day of Month

FIG. 2. LOAD OR OUTPUT DIAGRAM

der for a single large dynamo, special in design except for the smaller parts.

Practically every customer specifies a date when delivery of the completed apparatus is wanted; for example, 90 days from receipt of the order. Accordingly, in planning or laying out any order this date must be taken for the starting point and from it the dates figured backward as to when the various parts of the dynamo must be finished ready for assembling into a complete unit. Each part should next be similarly laid out to determine when the work upon it must begin in order to meet the required date for assembling into the whole, and thus the planning is extended sufficiently far back to include castings, punchings, raw material, patterns, dies, jigs and drawings.

In all of this, care must be observed to prevent conflict with other apparatus or parts going through the factory. Where such do occur, the interferences must be straightened out promptly.

It should not be assumed that planning is at all easy, for the reverse is the case. Before a starting or finishing date can be given on any piece or part, the various operations required must be analyzed both as to time and the machine tools involved, then investigated to see how many hours of work there are already ahead, after which dates for starting and finishing may be set. If any delay occurs which prevents work on a certain part from being started on a schedule time, effort must forthwith be made to rearrange the schedule either on it or on some other piece so that if possible the delay may be overcome in sufficient time to avoid affecting the promised date of delivery on the complete order. It is evident that a data sheet is required upon which may be recorded the planning just referred to, as well as the subsequent progress of the apparatus toward completion.

Planning Sheet and Progress Report

Such a planning or progress sheet is illustrated in Fig. 1. Reference to it shows two principal portions, for the stationary and the revolving part respectively, known otherwise in certain types of machines as field and armature. Aside from the data at the top, which is largely descriptive and need not enter into this discussion, it will be observed that in both portions of the sheet the names of all of the parts necessary to build this machine are laid out horizontally from left to right. Immediately underneath is placed the page number of the shop-manufacturing information for each item where full details will be found. Then follow in turn columns for the names of the various parts; the dates when the necessary information is wanted or promised to the manufacturing departments from the engineering and the drafting departments; the dates when the dies, formers and patterns are wanted or promised; the dates or promises of delivery on the raw materials; the dates or promises of competition on the machined or finished parts, and so on. By cross-hatching, as directed on the sheet, when information, materials, etc., are received, the progress of the order will be seen at a glance and any remaining blank spaces will

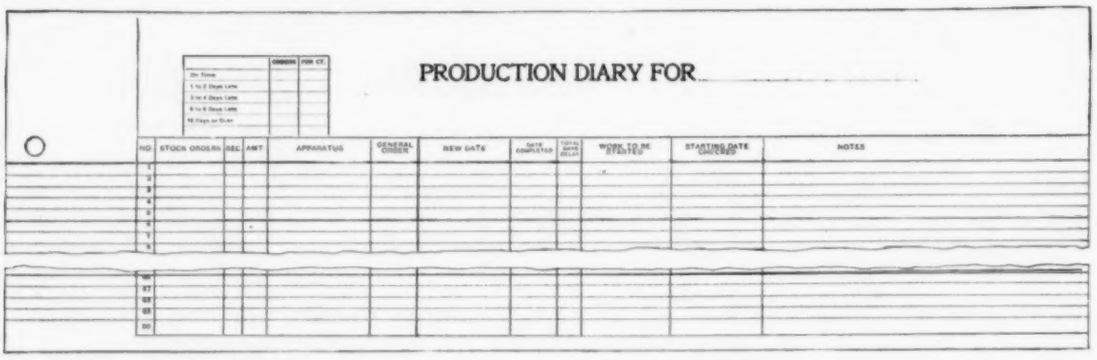


FIG. 3. GROUPING SHEET FOR CUSTOMERS' ORDERS

indicate the items tending to retard delivery. A scheme of this kind will not only enable a very clear idea to be obtained as to how long any machine will require under normal conditions of operation to complete it, thus enabling very accurate estimates to be made before the taking of an order, but it can likewise be used to follow subsequently the progress made in the building of a machine.

Load or Output Diagram

Fig. 2 illustrates a load or output diagram giving a pictorial view of the work of a department in somewhat similar manner to the preceding planning or progress sheet for a single unit. In this load diagram is given (*a*) the total of unfilled orders or uncompleted units, (*b*) the total actual orders or units completed, (*c*) the total

desired deliveries, (*d*) the orders or units scheduled for delivery and (*e*) the maximum possible output of the department. The closeness with which line (*b*) approaches line (*c*) is a measure of the efficiency of the department, while the approach of line (*c*) to line (*e*) is indicative of how full the department is of work. The rise or fall of line (*a*) shows whether the volume of work is increasing or decreasing and therefore whether the department is holding its own or falling behind, etc.

In many instances a customer's order calls for more than a single item, and as these may be built in different manufacturing departments, it is necessary to have a reference sheet for the purpose of tying them all together, thus permitting a general supervision from a central bureau to be exercised over all of the orders in the works. Fig. 3 is a sheet of this kind. Upon it are recorded daily customers' orders; a brief description, with the quantity of each item and the stock order on which it is to be built, being also set down, together with the general order number assigned to a customer's order as a whole. The date of the sheet itself gives the original promise of comple-

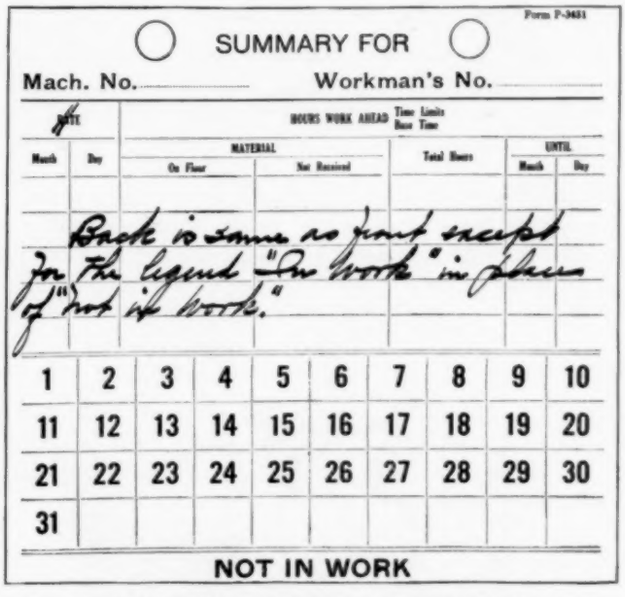


FIG. 4. COMBINED CALENDAR AND SUMMARY CARD

tion of the items, and further columns provide for new dates, etc. No sheet is lifted until all of the orders on it have been completed, thus furnishing an index as to the laxity or otherwise of the entire works in keeping delivery dates.

Reverting again to the customer's order for a single machine, the manufacturing information, as will have already been surmised from Fig. 1, will in many instances be issued piecemeal, those items taking longest to build or in which the raw materials require the greatest length of time to obtain being gotten out first. In any event, as such information is received the blueprints should be gone over by the time-study man and base or standard times, time limits or piecework prices, class of help and machine tools best adapted to the work set forth on suitable cards. These should be tabulated under drawing numbers and kept convenient to hand in the manufacturing department where the work is to be done. As soon as these data have been secured, time slips for the various operations should be written up in duplicate, the workmen's names being omitted. The time slips for each piece or part are to be arranged in sequence of operation and pinned together with an unsigned receipt for use upon completion of the piece. They are then to be filed in a suitable "Awaiting Material" box according to order number and held there until the arrival of the material. Coincidentally with this, a planning or progress sheet, Fig. 1, should be laid out, after which the material should be ordered for delivery as required. In order to lay out the planning or progress sheet it is of course necessary to know when the machine tools designated by the time-study man for the work will be available. This is obtained from a board called the dispatch board, of sufficient size to accommodate a time slip for every machine-tool operation or the equivalent bench hand in the department and provided with a set of two hooks for every such time slip. Each set of hooks is marked to correspond with the number or name of the machine tool, etc.

Combined Calendar and Summary Card

As material is received on any order, the time slips involved are removed from the "Awaiting Material" box and placed upon the set of hooks bearing the number or name of the tool, bench hand or the equivalent corresponding to that shown on the topmost time slip, care being taken in so doing to arrange the packages of time slips according to the way in which the orders are to be brought through. On top of all the time slips on every set of hooks is placed a combined calendar and summary card, Fig. 4. The function of this card is three-fold: First, it is intended to show if a tool, etc., is in work or standing idle, depending simply upon which side is exposed to view; secondly, by crossing off the date called for on the earliest time slip, a general idea is obtained as to whether or not a tool or operation is falling behind its schedule; thirdly, by sorting at suitable intervals all of the time slips according to tool or equivalent numbers and adding the time limits, or base times if preferred, the volume of work ahead of any tool or operation is ascertained, and if this column be further divided into two parts, one for material already received, the other for material not yet received, the amount of work immediately ahead of a tool or operation is obtained. These figures are then set down on the combined calendar and summary card and serve to indicate in busy times the advisability or otherwise of working overtime or double turn, of requisitioning the work in part to another department or of ordering additional equipment or facilities.

There are several distinct advantages to be derived from such a system of dispatching, among which may be mentioned: Starting work on schedule time and continuing it without delay through various operations and in the proper sequence; closer knowledge of production; ability to determine more readily the efficiency of machine tools or operations; ability to determine capacity of department in tools and workmen; relieving the foreman of a large part of purely clerical and routine work.

Instead of referring to the dispatch board itself to ascertain when any tool, bench hand or the equivalent will be available for incoming orders, a sheet may be prepared listing all of them according to numbers and setting opposite each one the date to which each is loaded with orders already received. This list may then be used in filling out on the time slips the starting dates of the various operations. With a list such as this it is of course unnecessary to run the summary feature.

It may be wondered why the time slips pertaining to any piece are all pinned together in sequence of operations and placed upon the set of hooks corresponding to the first operation instead of being hung at once upon their proper hooks. As a matter of fact, this latter method should be followed where the apparatus is standard and where there is little likelihood of a change of some kind being made in the order. In such cases also where the material can always be had when wanted, the time slips need not be placed in an "Awaiting Material" box, but may be hung upon their proper hooks on the dispatch board as soon as made out. Experience, however, shows that where the apparatus is special and there are, therefore, possibilities of changes requiring the recall of one or more of the time slips, it is far easier to collect them if placed on a few hooks.

By keeping the orders awaiting material in a separate box arranged according to order numbers, but with spacing cards showing the dates when the material is due, a "tickler" or "follow" record is obtained which is of assistance in the hurrying of material.

Operation of the Dispatch Board

The operation of the dispatch board is as follows: When a workman is in need of a job he reports to the clerk in charge of the dispatch board. The latter, upon being told the number of the machine tool or equivalent operated by the workman, lifts from the set of hooks corresponding to this number, first the combined calendar and summary card, then the set of time slips (which are in duplicate) immediately following it, these being the order requiring the earliest delivery. Since all of the time slips of this set are pinned together, the clerk unpins them, fills out the remaining unfilled items on the top time slip, checking or correcting the starting time, the original of which he hands to the workman. The other time slips of the set, with the receipt, are again pinned together. Upon the back of the receipt is now written the name of the workman who has just been given the first operation to do, after which the time slips and receipt are replaced upon the same set of hooks from which they were taken. When the first operation is completed the workman returns to the dispatch board with the completed time slip, handing it to the clerk. He in turn looks at the tool or equivalent number on it, lifting from the set of hooks corresponding to such number the combined calendar and summary card and the other time slips belonging to the job and setting them to one side with the completed time slip. He next lifts from the same set of hooks the succeeding package of time slips on the following order, giving the workman, as before, the top time slip corresponding to the first operation and going through precisely the same steps as just described.

The clerk then replaces the combined calendar and summary card; but the time slips of the first order, the first operation on which has just been completed, are now placed on the set of hooks corresponding to the second operation, the duplicate of the completed time slip first being removed. This is done by noting the tool number or equivalent on the top time slip. In placing them on the hooks the proper sequence with reference to the other orders is again observed. In giving the time slip covering the second operation on a job to a workman, he is told exactly where the material is, simply by referring to the back of the receipt slip pinned with the remaining time slips, on which has been written, as already stated, the name of the workman or the tool that did the preceding operation. As each operation is given to a workman his name is in like manner placed on the receipt slip immediately below the names of the other workmen who did the preceding operations, so that there is never any difficulty in locating the material.

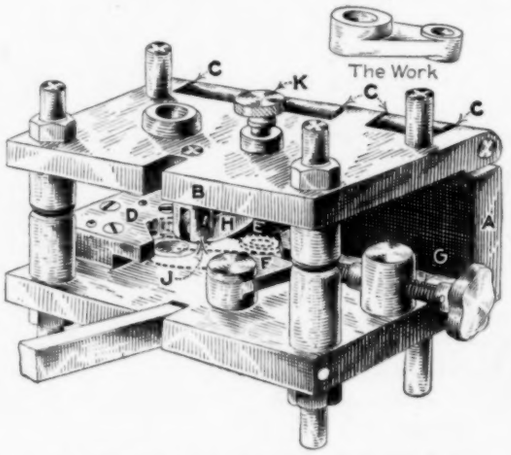
The time slips of completed operations are passed to the cost clerk for costing purposes. The cost clerk may or may not be the dispatch clerk, depending upon the size of the department.

The preceding scheme may, of course, be varied. For example, as soon as an operation is finished, the material may be removed to the storeroom for inspection and from there to the machine tool or bench, etc., where the next operation is to be performed. In such case the necessary cutting tools, jigs, etc., should also accompany it.

Handy Locating and Holding Device for Jigs

By B. W. Richards

In the illustration is shown a unique locating and clamping device for a drill jig. The part is a malleable-iron casting. The diameter and center distance of the holes must be extremely accurate; therefore no removable bushings are allowed. The jig was made so that the drilling was done from one side and the reaming from the other, the drill bushings being in the lid and the reamer bushing in the body. The main body *A* of the jig is a machine-steel forging accurately planed. The lid *B* is fixed on with taper pins, which can be driven in as wear



HANDY LOCATING AND HOLDING JIG

takes place. *C* are tool-steel plates, which reduce the wear at these points to a minimum, thereby maintaining the accuracy of the jig.

The machine-steel V-block *D* for locating the part is carbonized and hardened and is screwed and doweled to the body of the jig. The locating features of the jig are two pawls *E* and *F*, which are planed to an angle of 90 deg. The pawls are operated by the screw *G*, and can be run back out of the way, allowing the piece to be easily removed.

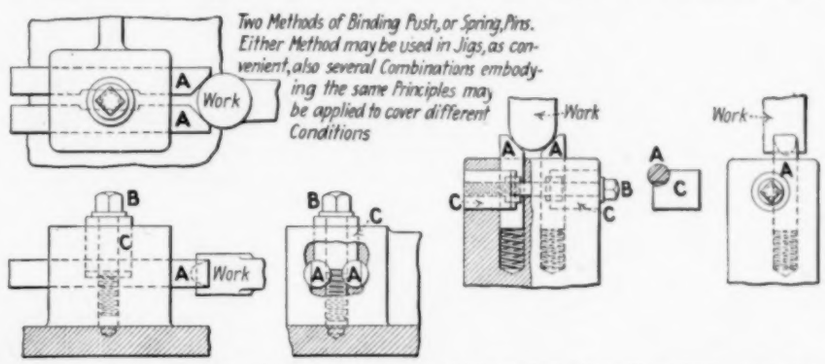
The clamp *H* is pivoted on the stud *J* and is fastened on the other end to another stud and operated to hold the piece by the knurled-head screw *K*, projecting through the jig lid *B*.

Practical Points on Jig Design--II

By Carl D. Wilder

SYNOPSIS—This article describes details of jig design that have been found by experience adaptable to different conditions and uses for which can be found in almost any set of jigs. The methods of locating, clamping, support to counteract spring and the like are taken up.

Methods of binding push pins or spring pins used to steady a piece of work by pressing against a rough surface are shown in Figs. 1 and 2. The pins *A* are round and are flattened for a part of their length on the side toward the binding bolt *B*, which keeps them from turning and also from falling out of the jig. The bushing *C* presses on both of them and does the binding. The arrangement in Fig. 1 is used where convenience dictates



FIGS. 1 AND 2. METHODS OF BINDING PINS USED IN STEADYING WORK

that the binding screw shall be at right angles to the plane of the pins and that in Fig. 2 where it must be parallel to that plane.

The most common type of box jig, which may be used with or without a cover, as the case may demand, is shown in Fig. 3. The cover is expensive to make and is seldom necessary unless the piece requires to be drilled on both the top and the bottom, in cases where the holes do not go through or in work that requires counterboring from both top and bottom.

Taper reaming is sometimes an awkward job when rapid production is necessary. The reamer shown in Fig. 4 is provided with a ground body above the flutes and a ground pilot below them, and also with an adjustable stop collar. The bushing *C* is a slip bushing which is preceded by a smaller one to guide the drill, which is a trifle under size for the small end of the hole.

When it is desirable to partly support the work on the drill bushings it is necessary that this bushing should be cut away in one of the two ways indicated in Fig. 5 so that the chips can escape. At *A* the work has a bearing on two points and the bushing, which is found desirable where the face of the hub has been machined, while *B* shows a method of cutting away all but one bearing point, which is better for hubs having rough faces.

There are also cases in which the obvious way to locate the piece is by means of a hub which has been previously chucked or drilled and faced. In such cases, and when it seems advisable to bind the work by means of the same plug which locates it, the two methods shown in Figs. 6 and 7 are suggested. They are both expensive ways and should only be resorted to when there is no other, more easy, way to bind the work, or when the rapidity with which the locating and the binding can be done is a considerable factor. In both cases, as the sketches clearly show, the locating plug has one side of a square thread cut upon it, which catches under a steel plate fastened to the jig body.

A casting is often encountered which appears to need support at four points in the jig. It may be too light to stand the machining operation unless it is supported in more than three points. The method of getting a four-point and a three-point support at the same time is shown in Fig. 8. The rocker *A* bears at one point on the body of the jig and at two points on the casting, so that the casting may be located and supported as if on three points while getting the rigidity due to an additional bearing point. It is obvious that a rocker may be introduced at each of the three bearing points on the jig, thus getting as many as six bearings on the work without sacrificing any of the advantages of the three-point support.

When spring pins are used in addition to the three-point bearing it is customary to bind them after they have once come to a bearing, so that they cannot follow up the spring of the casting as a result of the machining operation. Two forms are used, depending on whether the work is to be clamped on top of the pin or not. A pin with a flat milled at 3 to 5 deg. to the axis is shown in Fig. 9. This is kept from falling out by the

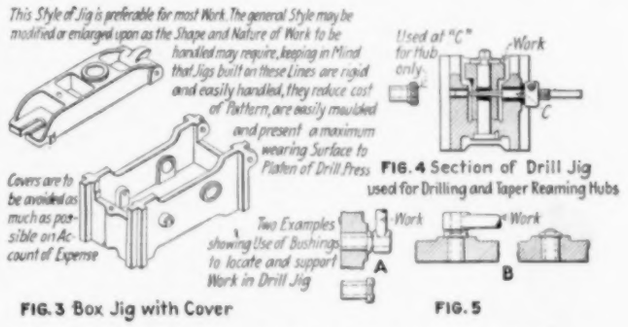

This Style of Jig is preferable for most Work. The general Style may be modified or enlarged upon as the Shape and Nature of Work to be handled may require, keeping in Mind that Jigs built on these Lines are rigid and easily handled, they reduce cost of Pattern, are easily moulded and present a maximum wearing Surface to Platen of Drill Press
Covers are to be avoided as much as possible on Account of Expense
Two Examples showing Use of Bushings to locate and support Work in Drill Jig
A
Used at "C" for Hub only
Work
C
Work
Work
B

FIG. 3 Box Jig with Cover

FIG. 4 Section of Drill Jig used for Drilling and Taper Reaming Hubs

FIG. 5

FIGS. 3 TO 5. ADVANTAGEOUS JIG FEATURES

pivot-point setscrew *B* and held in position by tightening the square-head setscrew *C*. If the binding of the work is to be down on the spring pin, the angle of the milled slot in Fig. 10 is made about 10 deg. and the pin is held from turning and kept from falling out or slipping back by the setscrew *D*, which bears on the flat-pointed pin *E*. It is possible to carry this method of binding spring pins to the extreme shown in Fig. 11, where four such pins are arranged to be clamped in place by a turn of one nut. The main binder screw *F*

carries equalizing levers G on each end, and these in turn press on four plugs which correspond to the plug E in Fig. 10.

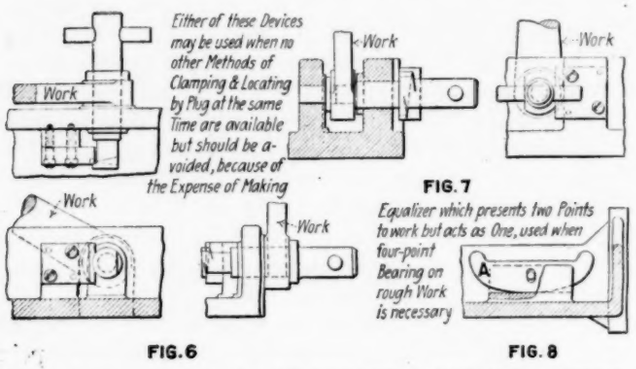
Instead of spring pins, two adjustable pins can be raised or lowered together by one adjusting screw, as shown in Fig. 12. The central screw A bears on the conical point of two rods B, which in turn bear on the beveled ends of the two adjustable pins C.

A problem which occurs in many machine tools is that of drilling the ends of forked levers for the pins. This may be handled as shown in Fig. 13, when the lever is to be located by the fork, as is very often necessary. The ends of the locating piece A are turned or filed eccentric, as indicated by the radius lines R, this eccentricity being made enough to take care of any variation in the castings. This acts not merely as a centering device but also as a stop against which to take the thrust of the drill. In case the lever is located by the other two hubs, the block C, Fig. 14, is still made with eccentric ends, but it is slotted in the center, so that it can be moved either way on the binder bolt.

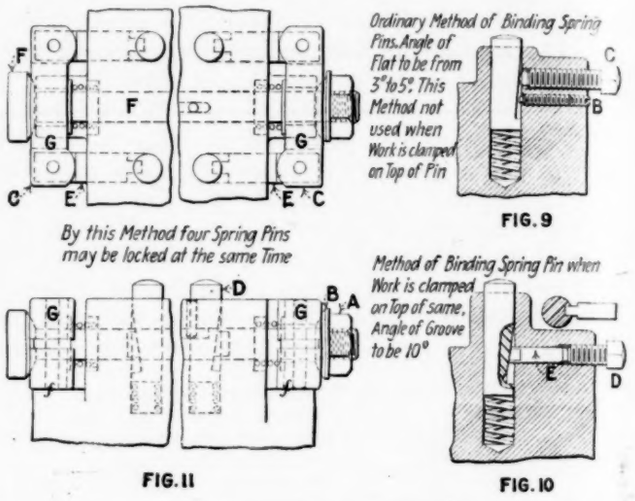
It is often desirable to clamp a piece of work securely at some point without bringing a strain on the locating device. The way to do this is shown in Fig. 15, in which the setscrew A is tightened on the work first and then the binder B is set up.

An eccentric bushing which is used in cases where two holes are so close together that they cut into each other or come too close for the use of separate bushings is shown in Fig. 16. The stop C is so placed that the flats on the bushing will locate it in each of its positions. A bushing shown in Fig. 17 is threaded on the outside so that it may be screwed down upon the work and thus act as a binder. It leaves no clearance for chips, which must all come up through the bushings. Thin work, whether it is to be milled, drilled or machined in any other way, is always troublesome to hold. A way to do this which has proved satisfactory, although somewhat costly to build, is shown in Fig. 18. The work is held between the hinged dog A and the slanting clamp B. The tendency of the dog is to swing downward around D as a center and the tendency of B is also to swing downward around C as a center. In this way both sides of the work are pressed down and there is little chance for it to lift or loosen.

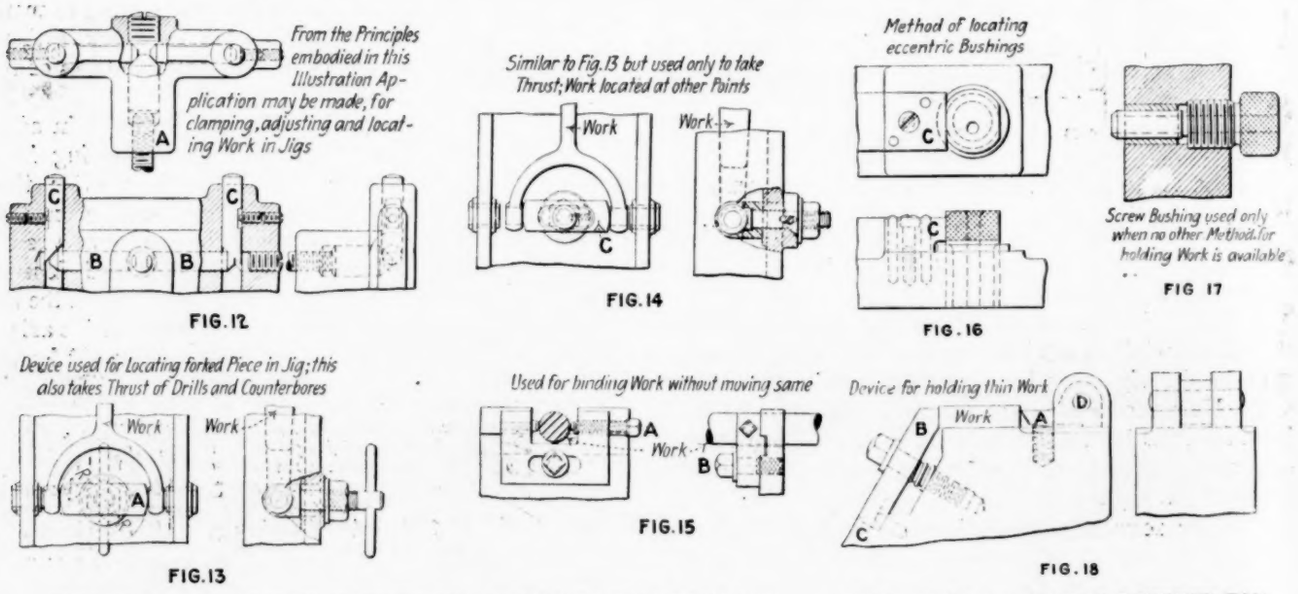
A standard method for drilling and reaming holes, and one which overcomes some objectionable features of drilling through a bushing, is shown in Fig. 19. A spot


Either of these Devices may be used when no other Methods of Clamping & Locating by Plug at the same Time are available but should be avoided, because of the Expense of Making
Work
Work
Work
Work
Work
Equalizer which presents two Points to work but acts as One, used when four-point Bearing on rough Work is necessary
A
FIG. 6
FIG. 7
FIG. 8

FIGS. 6 TO 8. METHODS OF LOCATING AND SUPPORTING WORK IN JIGS


Ordinary Method of Binding Spring Pins. Angle of Flat to be from 3° to 5°. This Method not used when Work is clamped on Top of Pin
By this Method four Spring Pins may be locked at the same Time
Method of Binding Spring Pin when Work is clamped on Top of same. Angle of Groove to be 10°
F
G
E
C
B
D
A
FIG. 9
FIG. 10
FIG. 11

FIGS. 9 TO 11. VARIOUS METHODS OF BINDING SPRING PINS TO SUIT CONDITIONS



FIGS. 12 TO 15. HELPFUL DESIGNS FOR CLAMPING, LOCATING AND ADJUSTING WORK IN JIGS

FIGS. 16 TO 18. HANDY DESIGNS FOR DIFFICULT WORK

drill with a solid shank and body, as shown in *A*, is used to spot to hole. This is run down until the stop strikes. Then the slip bushing is removed and a twist drill put through, guided only by the spot. This leaves ample room for chips, and also avoids the scoring of the drill bushing, which so often happens if production is pushed. When the hole is to be reamed, the slip bushing is reinserted in *C*. A counterbore, which is made to fill the lining bushing rather than to be guided by the pilot, is shown in Fig. 20. In operation it comes down to a stop ring on the counterbore.

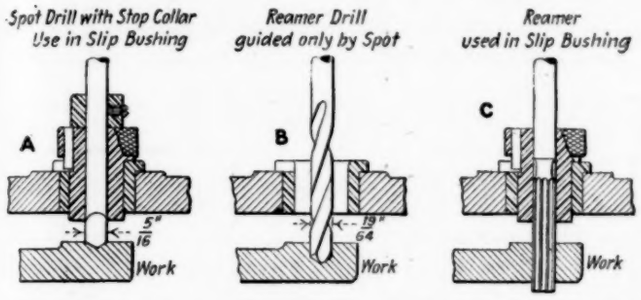


FIG. 19. OVERCOMING OBJECTIONABLE FEATURES OF DRILLING THROUGH BUSHINGS

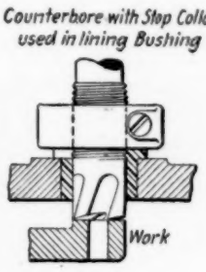


FIG. 20. HANDY COUNTERBORE

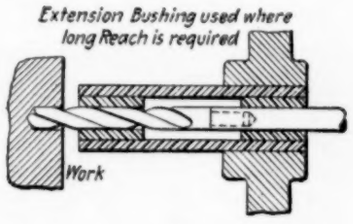


FIG. 21. EXTENSION DRILL WHICH REDUCES FRICTION

An extension drill with the two parts sweated together, running in two short bushings, is shown in Fig. 21. This avoids the friction due to a long drill and bushing and the difficulty of making it straight.

Making Steel Tanks with the Oxyacetylene Torch

The Prest-O-Lite Co., Inc., Indianapolis, Ind., uses oxyacetylene welding and cutting torches quite extensively in manufacturing tanks and other sheet-metal parts. In Fig. 1 is shown one of the welded tanks used for purifying acetylene before forcing it into the shipping tanks.

The tank is made of No. 10 gage steel and is 4 ft. 6 in. by 9 ft. by 29 in. high. About 179 ft. of welding is necessary. The time required for welding the part is 9½ hr., and approximately 200 ft. of oxygen and an equal amount of acetylene are needed, the Prest-O-Lite torch being of the equal-pressure type.

In Fig. 2 is shown a tank used for holding a cyanide solution. The part is 40x48x28½ in. and is made from 3/16-in. steel. In making the tank 6 welds and approximately 20 ft. of welding are required. This work is performed in 3 hr., and about 135 ft. of each gas is utilized.

When welding a type of steel rings, the part is held in the fixture shown in Fig. 3, *A* being held by tightening up the handle *B*, which draws the jaws together and holds the ring in position. The joint is then tacked with the welding torch. The ring is later welded to make the joint complete. The illustration shows one of these rings being welded by the operator.

In Fig. 4 are shown three types of belt guards that have been made with the welding torch. The guard *A* measures 34½ in. by 18 in. deep and is made from 1¼ in. by 3/16-in. thick angle iron.

In making the part, 20 welds are required. The time necessary is 25 min. For welding the guard, approximately 20 ft. of each gas is used. The guard *B* is 69 in. by 19 in. mean width by 12½ in. deep and is made from a similar section of angle iron.

In making this part, 13 welds are necessary, 11 ft. of each gas being used. The time required is about 15 min. The wheel guard *C* is also made with the welding torch. This part is 75 in. high, 33 in. wide at the top, 21 in. wide at the bottom and 15 in. deep, the section of angle iron being the same.

For making this guard, 26 welds are required; the time necessary is 35 min., and 25 ft. of each gas is consumed.

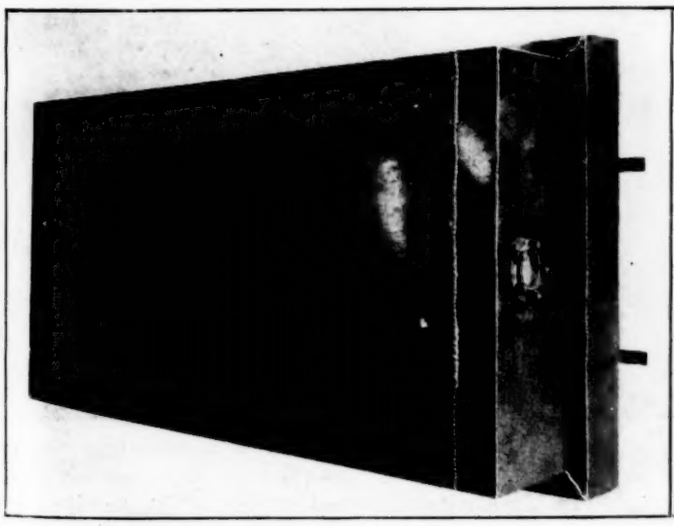


FIG. 1. WELDED ACETYLENE PURIFIER TANK

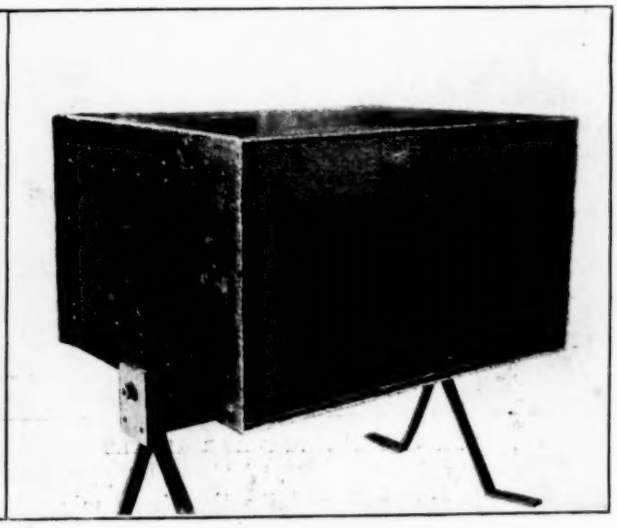


FIG. 2. WELDED CYANIDE TANKS

In Fig. 5 is shown the operator welding grates used on the driers for purifying gas. These grates are made of 24 bars 26x¾ in. by $\frac{3}{16}$ in. thick. In building up, 96 welds are necessary. The time required is 1½ hr., and approximately 65 ft. of each gas is consumed.

In the illustration the operator is shown welding one of the grates, and one finish welded is shown at the rear.

One of the hangers used for supporting the grates is shown in Fig. 6. This part is 29x26 in. by 10 in. high and is made from 1¼x$\frac{3}{16}$-in. angle iron.

The top is first welded on the four corners; then the four legs are welded on. For doing this work 15 ft. of each gas is consumed, and the time is 20 min. In the illustration one of the legs is shown welded, the operator welding another and two legs cut to length are resting on the top at the rear.

These last two operations are welding work for parts used in the drier. This welding is usually given to apprentices going through the shops of the Prest-O-Lite Company. They furnish good practice as the parts are not very heavy in section, and though they must be rigid, great strength is not of vital importance. Likewise, the finish of the weld is not important on this work.

Drawing Temper Several Times Better Than Only Once

By Charles Doescher

Here is a hardening kink that I have often made use of, and one that I can readily vouch for as being O.K. for hardening delicate piercing punches, forming punches, forming arbors or other work that is liable to break when in use.

The punch or arbor is hardened in the usual way, except that the temper is drawn at least two or three times, and instead of allowing the punch to cool off in the oil after the temper is drawn, as is the common practice, it is immersed in the oil, quickly withdrawn and allowed to cool off in the air.

When cool, the punch is given a couple of rubs with the emery-cloth stick, again drawn down to a blue, once more immersed in the oil and allowed to cool off gradually in the air.

The results obtained are surprising, and while this kink may not be new to all, it is nevertheless not as generally known and used as it should be.

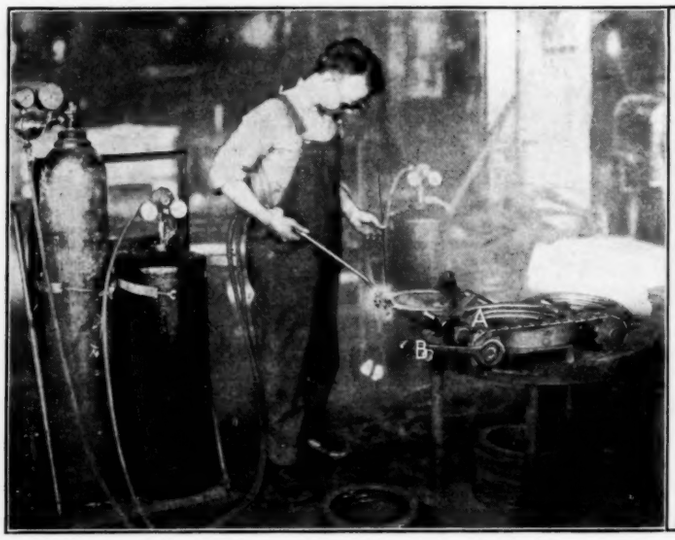


FIG. 3. WELDING FIXTURE FOR RINGS

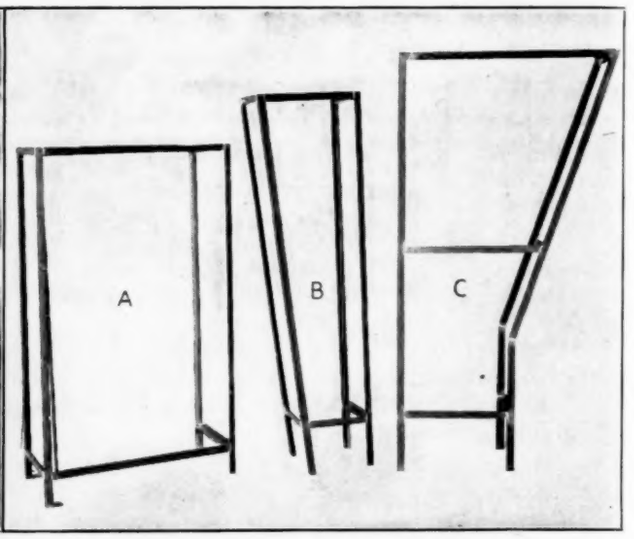


FIG. 4. WELDED BELT GUARDS

FIG. 5. WELDING DRIER GRATES

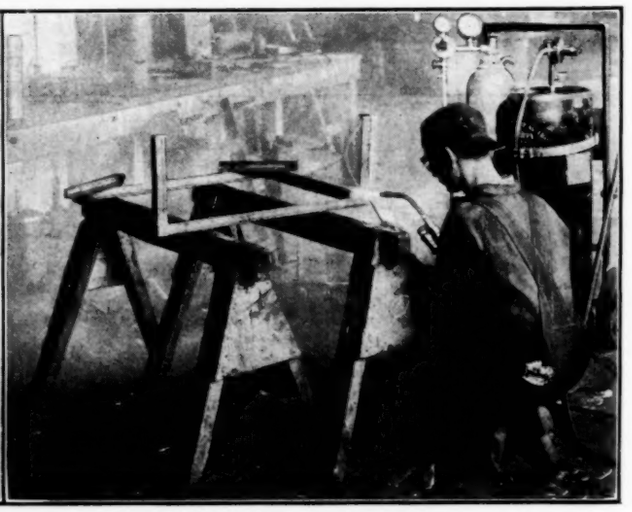


FIG. 6. WELDING GRATE HANGERS

Empirical Design of Gas-Engine Crankshafts

By G. W. Lewis* and A. G. Kessler†

SYNOPSIS—In this article the authors have analyzed over 40 different American gas engines and have given formulas and charts for finding the crankpin diameter, bearing-length diameter of main journal, length of journal, center distances between main bearings, thickness and width of crank webs, length of flywheel hub, and overall length of crankshafts. Some of these data have been placed in tabular form, so that they are readily accessible for use by the designer or engineer.

There have been more failures in the crankshafts of gas engines than in any other member. For this reason the design of the crankshaft calls for the use of the best judgment of the designer, together with a careful study

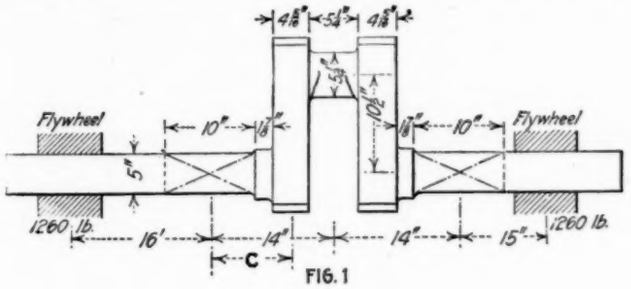


FIG. 1

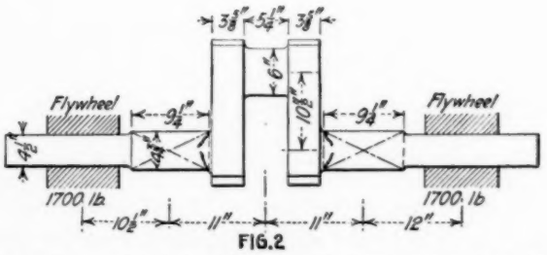


FIG. 2

FIGS. 1 AND 2. EXAMPLE OF BADLY DESIGNED SHAFTS

of all the data that he can gather about crankshafts in actual use. It is to aid in the design of this important part of the engine that the following article has been written.

Because failures of crankshafts are all too common and because many of these are due to faulty design, accounts of two shaft failures are here given. These are taken from the report of the British Engine, Boiler and Electrical Insurance Co. and furnish examples of the weak points of the design, showing a few of the many errors that must be avoided.

In Fig. 1 is shown a shaft of a horizontal illuminating gas engine that failed after seven years' service. The diameter of the engine cylinder was 13½ in., the stroke 21 in. and the speed 160 r.p.m. The shaft was of the two-bearing two-flywheel type and failed at the fillets at both ends of the crankpin after the engine had made 150,000,000 revolutions and about 67,000,000 explosion strokes. The maximum stress in the pin was from 25,000 to 26,000 lb. per sq.in. This is abnormally high, since American practice would give a maximum stress of about 19,000 lb. per sq.in. in the crankpin of an engine of the same dimension. In Fig. 2 is shown a shaft of a horizontal engine of the following dimensions: Cylinder diameter, 12 in.; stroke, 18 in., and speed, 160 r.p.m. This shaft was also of the two-bearing two-flywheel type and failed in the left-hand shoulder next to the crank web after being in operation ten years. The maximum working stress in the shoulder was only 8,500 lb. per sq.in., the failure being due to the fact that there were practically no fillets at the junction of the shoulder and crank web. This shaft made 228,000,000 revolutions and was subjected to about 72,000,000 explosions.

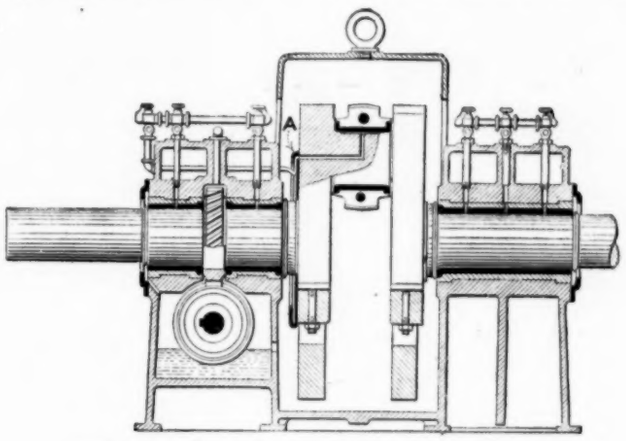


FIG. 3. CENTRIFUGAL RING LUBRICATOR

In designing the crankshaft the following items must be considered and allowed for: (a) The oil feed to the crankpin must be automatic and positive. (b) The oil feed to the main bearing must be positive and no oil must be thrown from bearing. (c) Arrangement must be made for driving the side shaft which operates the valve gear and the governor.

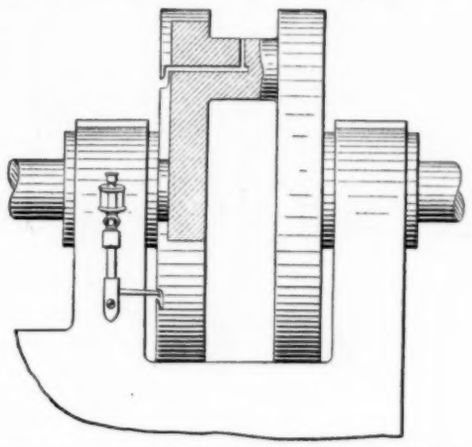


FIG. 4. RING IN BALANCE-WEIGHT OILER

The crankpin is generally lubricated by a centrifugal ring lubricator such as is shown at *A* in Fig. 3. The oil is fed from a sight-feed lubricator into the ring and is

*Assistant professor of engineering, Swarthmore College.
†General manager, Lakeside Forge Co., Erie, Penn.

driven by centrifugal force into the deep channel turned in the inside of this ring and passes from there through a hole in the crank web to the crankpin bearing. In Fig. 4 is shown a method whereby a ring is turned in the balance weight, oil being fed to this ring from an oil cup with sight feed. In Fig. 5 is shown a forced-feed system where the oil is pumped through the pipe *A* into the oil ring

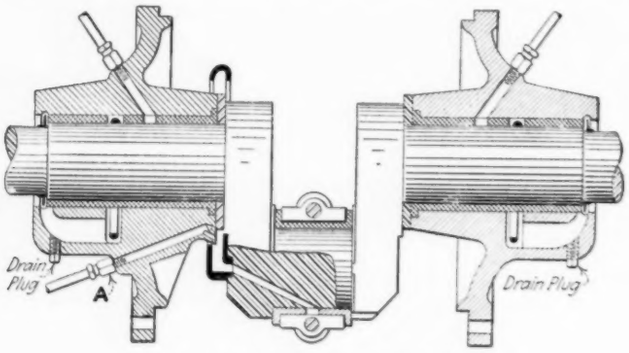


FIG. 5. OIL GUARDS FOR OILERS

and from there carried by centrifugal force to the crankpin bearing.

The main bearing is lubricated either by gravity-forced feed or ring oiled from a well. In Fig. 3 oil is fed by gravity or forced feed to the main bearing through sight feeds, and is prevented from being thrown from the bearing by a fender ring and guard at the end of the bearing. This fender ring may be a part of the shaft, as shown, or may be made separate, as in Fig. 5, the latter being the cheaper method. In this case the oil is pumped to the main bearing and the oil caught on the fender rings flows to a well under the bearing and is returned to the bearing by a ring oiler. A cheaper method for lubricating the main bearing, and one used on small engines, is shown in Fig. 6. Here the oil is fed from a cup by a wick, just enough oil being fed

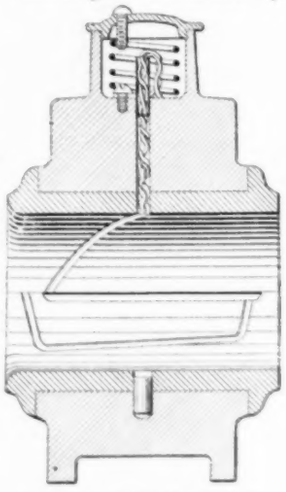


FIG. 6. CHEAP TYPE OF OILER

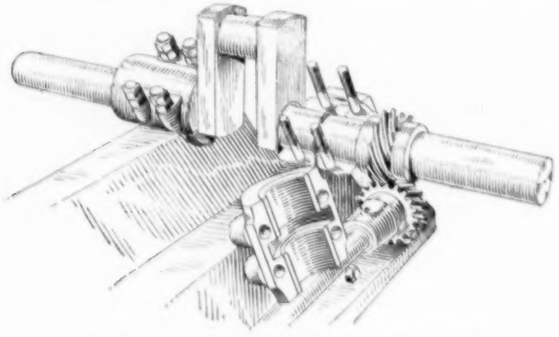


FIG. 7. METHOD OF MOUNTING GEARS

so that there is practically no excess to be thrown from bearing. In Fig. 7 is shown a chain oiler, the box cap of the bearing being removed.

Allowance must be made in designing a crankshaft for the placing of a gear on the shaft to drive the lay or side shaft. This can be done by either a bevel or spiral gear. In the smaller and cheaper engines the valve-gear is driven by a spur gear. The driving gear is nearly always placed on the shaft between the flywheel and the main bearing, as in Fig. 7, but in some engines it is placed between the crank web and main bearing. In Fig. 3 the gears are located in the main bearing and run in an inclosed oil bath. Allowance must also be made for a shoulder between the main bearing and the crank web. The diameter of this shoulder is 1.25 times the diameter of the main journal, and the width varies from $\frac{3}{16}$ to 1 in.

The crankshaft, crank webs and crankpin are made in one piece, a solid-steel forging finished all over. In most cases the forging is made of from 0.35 to 0.45 per cent. carbon openhearth steel with a tensile strength of from 60,000 to 80,000 lb. per sq.in. and a ductility of from 18 to 20 per cent. A nickel steel composed of Ni, 3.50 per cent.; carbon, 0.30 to 0.40 per cent.; Mn, 0.50 to 0.80 per cent., and Si, 0.20 per cent., is also used and has the following physical properties when annealed: The tensile strength is 110,000 lb. per sq.in.; elastic limit, 85,000 lb. per sq.in., and ductility, 24 per cent.

The following empirical formulas for the dimensions of gas engine crankshafts were obtained from data re-

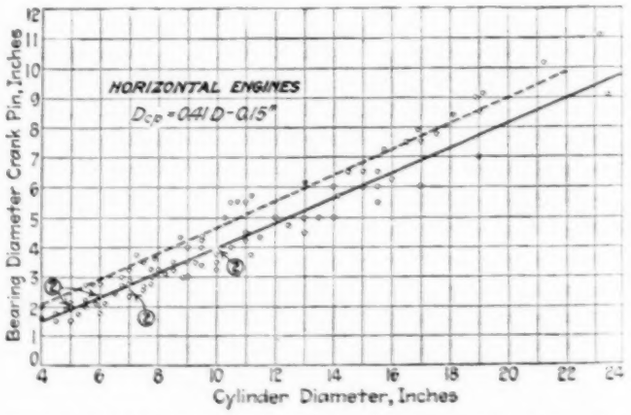


FIG. 8. CRANKPIN DIAMETERS—HORIZONTAL ENGINES

ceived from manufacturers of American engines. From the curves it is seen that the equations are the average of from 40 to 100 different engines in use.

In determining the dimensions of the crankpin the maximum unit bearing pressure from average practice should be under 2,000 lb. per sq.in. and the maximum fiber stress due to bending be less than 22,000 lb. per sq.in. Haeder for German practice gives a limiting value of 1,400 lb. per sq.in. for maximum allowable bearing pressure and a maximum allowable fiber stress of from 14,000 to 17,000 lb. per sq.in. The crankpin diameter for horizontal engines is obtained empirically from Fig. 8 in terms of the cylinder diameter. The relation is given by the following equation

$$D_{cp} = 0.41\,D - 0.15 \text{ in.} \qquad (1$$

where

D_{cp} = Diameter of crankpin;
D = Cylinder diameter.

German average practice from Haeder was also plotted and is shown by the dashed curve. For vertical engines the following average relation was found:

$$D_{cp} = 0.41\,D \qquad (2$$

To obtain the bearing length of the crankpin, the diam-

eter pin was plotted against length of pin in Fig. 9, the resulting average equation for horizontal engines being

$$L_{cp} = 1.015\,D_{cp} + 0.07\ in. \quad (3)$$

and for vertical engines

$$L_{cp} = 1.22\,D_{cp} - 0.33\ in. \quad (4)$$

where

L_{cp} = Bearing length of crankpin;
D_{cp} = Bearing diameter of crankpin.

The average German practice is indicated by the dashed curve and shows that a much larger pin is used for the same cylinder diameter. It also shows that for crankpins of 5 in. and over the bearing length of the crankpin is made equal to the bearing diameter.

The diameter of the main journal for horizontal engines is obtained in terms of the cylinder diameter from Fig. 10, the empirical equation being

$$D_{mj} = 0.455\,D - 0.45\ in. \quad (5)$$

and for vertical engines

$$D_{mj} = 0.5\,D - 0.5\ in. \quad (6)$$

where

D_{mj} = Diameter of main journal;
D = Cylinder diameter.

German average practice is also shown by the dashed curve, and shows that a much larger shaft is used, especially for the smaller sized engines. The length of the

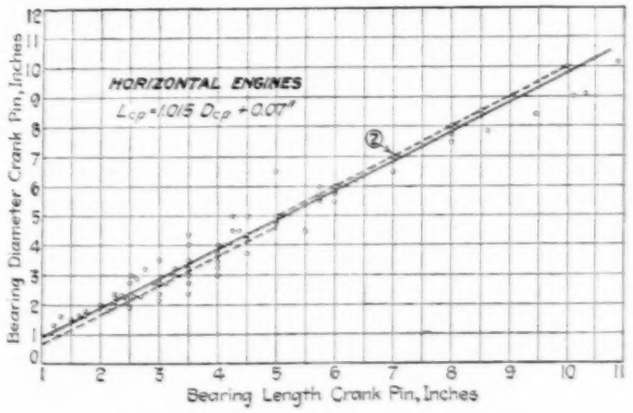


FIG. 9. CRANKPIN BEARING LENGTH

main journal in terms of the main journal diameter for horizontal engines is determined from Fig. 11 and is expressed by equation 7:

$$L_{mj} = 2.33\,D_{mj} - 0.5\ in. \quad (7)$$

For vertical engines

$$L_{mj} = 1.36\,D_{mj} + 1.3\ in. \quad (8)$$

where

L_{mj} = Bearing length of main journal;
D_{mj} = Bearing diameter of main journal.

Average German practice for horizontal engines is given by the dashed curve. The variation in the distance between the center lines of the main journal is due to the fact that shoulders of different width are used between the crank webs and main journals, and also that the gear for driving the valve and governor mechanism is sometimes placed between the main journals. To obtain an empirical equation for this distance, Fig. 12 was plotted between the cylinder diameter and the distance between the center lines of the main journals, the average equation being

$$L_{j\text{-}j} = 1.82\,D - 1.05\ in. \quad (9)$$

For vertical engines

$$L_{j-j} = 1.25\,D + 3.25\ in. \quad (10)$$

where

L_{j-j} = Distance between center lines of main journals;
D = Cylinder diameter.

Having obtained empirically the diameters of the shaft and the lengths of crankpin and journals, the next step is to determine empirical formulas for obtaining the dimensions of the crank webs. The web carries a direct

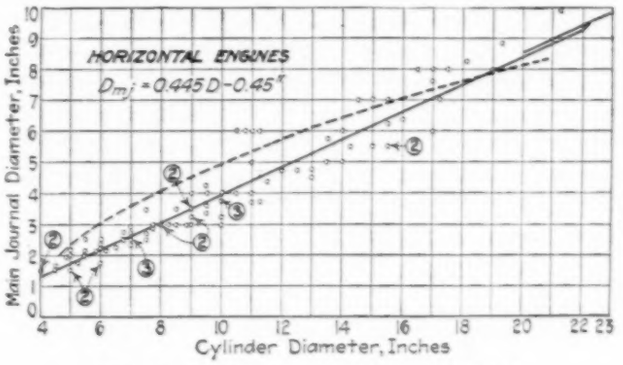


FIG. 10. DIAMETER OF MAIN JOURNAL

compression equal to one-half the explosion load and is also subjected to a bending moment, so that its strength is directly proportional to its width, W_{cw}, and to the square of its thickness, T_{cw}, the web being rectangular in section. The thickness of the crank web for horizontal

TABLE 1. DIMENSIONS FOR CRANKPIN

D, in	4	6	8	10	12	14	16	18	assumed
Dcp, in	1½	2⅝	3½	4	4⅝	5½	6⅞	7⅞	eq. (1)
Lcp, in	1½	2⅝	3½	4½	4⅝	5½	6½	7½	eq. (3)
Acp, in	2.44	5.63	10.13	16.5	23.75	32.4	42.7	54.9	Dcp × Lcp
Lj-j, in	6¼	9¼	13¼	17¼	20¼	24¼	28¼	32.0	eq. (9)
Pm				300					assumed
Kcp	1,350	1,300	1,480	1,430	1,430	1,430	1,410	1,390	eq. (14)
Sep	18,000	17,180	16,770	16,100	16,150	16,200	16,200	15,900	eq. (16)
Pm				350					assumed
Kcp	1,810	1,750	1,730	1,670	1,670	1,670	1,630	1,620	eq. (14)
Sep	21,000	20,000	19,650	18,830	18,900	18,900	18,900	18,500	eq. (16)
Pm				400					assumed
Kcp	2,060	2,010	1,980	1,900	1,910	1,900	1,880	1,850	eq. (14)
Sep	24,000	22,900	22,500	21,300	21,600	21,600	21,600	21,100	eq. (16)

and vertical engines from Fig. 13 is given in terms of crankpin diameter in equation (11):

$$T_{cw} = 0.62\,D_{cp} \quad (11)$$

where

T_{cw} = Thickness of crank web;
D_{cp} = diameter of crankpin.

German practice follows this relation very closely. The

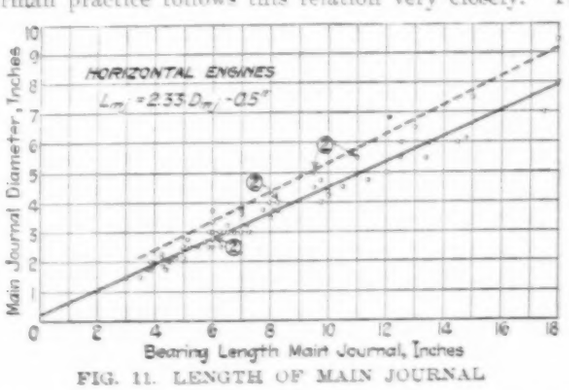


FIG. 11. LENGTH OF MAIN JOURNAL

width of the crank web for horizontal and vertical engines is also determined in terms of the crankpin diameter in Fig. 14, giving the following average relation:

$$W_{cw} = 1.27\,D_{cp} \quad (12)$$

where

W_{cw} = Width of the crank web;
D_{cp} = Diameter of the crankpin.

The diameter of the shaft of the flywheel for horizontal and vertical engines from Fig. 15 is seen to be equal to the diameter of the main journal, except in a few cases where one flywheel is used, an outboard bearing being used especially for shafts more than 7 in. in diameter. The

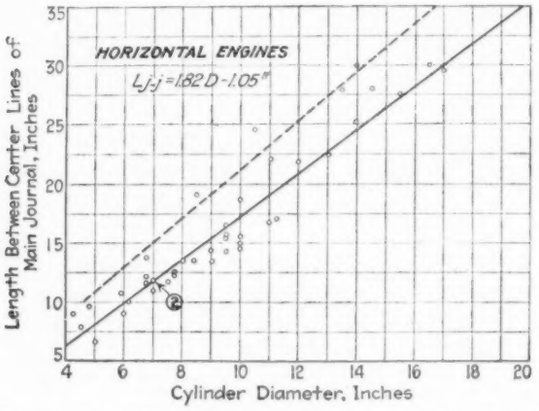


FIG. 12. CENTER DISTANCES FOR MAIN BEARINGS

length of the flywheel hub from Fig. 16 for horizontal and vertical engines is given by equation (13) in terms of the diameter of the flywheel shaft:

$$L_{fw} = 2\ D_{fw} \qquad (13)$$

where

L_{fw} = Length of flywheel hub;
D_{fw} = Diameter of flywheel shaft.

The dashed curve is the average German relation between length of flywheel hub and shaft diameter where only one flywheel is used.

Overall Length of Crankshaft

The overall length of crankshaft depends a great deal on individual design and the placing of the valve-gear and drive pulley; but to obtain an average equation for this equation for horizontal engines the overall length

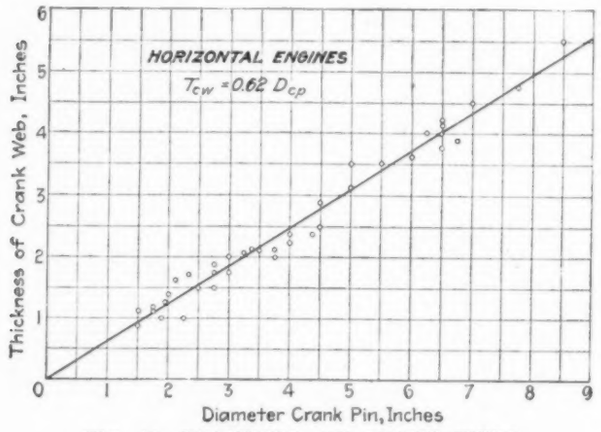


FIG. 13. THICKNESS OF CRANK WEBS

was plotted against the cylinder diameter in Fig. 17 and the following equation obtained:

$$L_{cs} = 5.45\ D - 1.8\ in. \qquad (14)$$

where

L_{cs} = Overall length of crankshaft;
D = Cylinder diameter.

To check the foregoing empirical equations and to find the limiting maximum bearing pressures and maximum fiber stresses, the following tables contain the various dimensions of crankshafts for engines within the range of the data used. The maximum bearing pressures and maximum stresses in the various parts of the crankshaft occur under the explosion load when the engine is on the head-end dead center. Table 1 gives the bearing diameter D_{cp}, bearing length L_{cp} and the bearing area A_{cp} of the

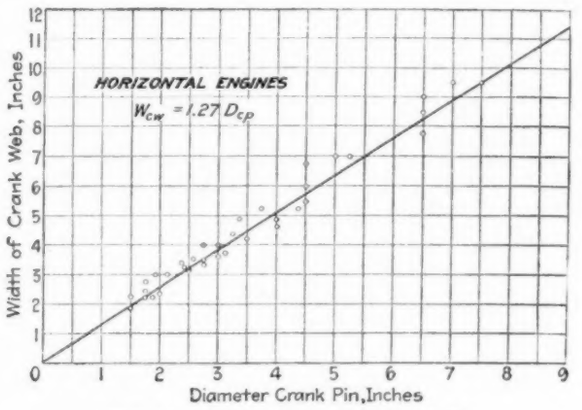


FIG. 14. WIDTH OF CRANK WEBS

TABLE 2. DIMENSIONS FOR MAIN JOURNAL

D, in.	4	6	8	10	12	14	16	18	assumed
Dmj, in.	1 1/4	2 3/8	3 1/2	3 13/16	4 1/2	5 1/2	6 1/2	7 1/2	eq. (5)
Lmj, in.	2 1/2	3 1/8	6 1/2	8 1/2	10 1/2	12 1/2	14 1/2	17	eq. (7)
Amj, in	3.29	10.13	20.35	34.42	51.8	74.45	99.2	131.3	Dmj × Lmj
Pm				300					assumed
Kmj	575	418	369	342	328	311	305	302	eq. (15)
Pm				350					assumed
Kmj	670	487	435	400	383	362	355	353	eq. (15)
Pm				400					assumed
Kmj	765	557	493	456	438	413	406	403	eq. (15)

TABLE 3. CRANK WEB

D, in.	4	6	8	10	12	14	16	18	assumed
Tcw, in.	3/4	1 1/8	1 1/2	2 1/16	2 1/4	3 1/2	4	4 1/2	eq. (11)
Wcw, in.	1 1/2	2 1/8	4	5 1/4	6 1/2	7 1/2	8 3/4	9 1/2	eq. (12)
Acw	1.76	4.22	7.74	12.33	17.97	24.95	32.75	41.7	Tcw × Wcw
Pm				300					assumed
Sb	12,700	12,550	12,470	12,530	12,530	12,100	12,100	12,200	eq. (18)
Sc	1,070	1,000	970	955	940	925	920	915	eq. (17)
Scw	13,770	13,550	13,440	13,490	13,470	13,030	13,020	13,120	Sb + Sc
Pm				350					assumed
Sb	14,800	14,600	14,600	14,650	14,650	14,120	14,100	14,260	eq. (18)
Sc	1,250	1,170	1,140	1,100	1,100	1,080	1,070	1,070	eq. (17)
Scw	16,050	15,770	15,740	15,750	15,750	15,200	15,170	15,330	Sb + Sc
Pm				400					assumed
Sb	16,900	16,700	16,700	16,770	16,700	16,150	16,100	16,300	eq. (18)
Sc	1,430	1,340	1,300	1,270	1,260	1,240	1,230	1,220	eq. (17)
Scw	18,330	18,040	18,000	18,040	17,960	17,390	17,330	17,520	Sb + Sc

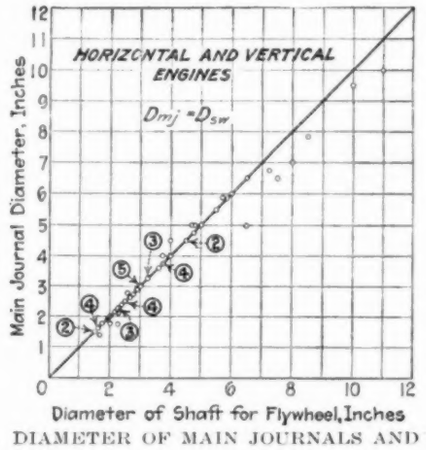


FIG. 15. DIAMETER OF MAIN JOURNALS AND SHAFT

crankpin. It also gives the unit bearing pressure K_{cp} computed from the following equation:

$$K_{cp} = \frac{0.7854\ D^2\ .\ P_m}{A_{cp}} \qquad (15)$$

where

D = Cylinder diameter;
P_m = Maximum explosion pressure;
A_{cp} = Projected area of crankpin

for the maximum explosion pressures of 300, 350 and 400

main journal in terms of the main journal diameter for lb. per sq.in. Table 2 gives the same data and the maximum unit bearing pressure on the journals computed from the following equation:

$$K_{mj} = \frac{0.7854\ D^2\ .\ P_m}{A_{mj}\ .\ 2} \qquad (16)$$

where

D = Cylinder diameter;
P_m = Maximum explosion pressure;
A_{mj} = Projected area of main journal.

Table 1 also gives the maximum fiber stress S_{cp} in the

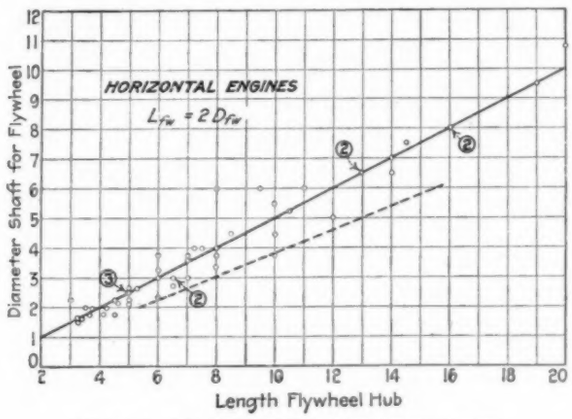


FIG. 16. LENGTH OF FLYWHEEL HUB

crankpin under the foregoing loadings. S_{cp} is obtained from the following equation:

$$S_{cp} = \frac{8\ P_m\ .\ D^2\ .\ L_{j-j}}{D_{cp}^3} \qquad (17)$$

where

D = Cylinder diameter;
P_m = Maximum explosion pressure;
L_{j-j} = Equation (7);
D_{cp} = Equation (1).

In computing the fiber stress the weight of the flywheel has been neglected.

Table 3 gives the thickness, T_{cw}, the width, W_{cw}, and the area, A_{cw}, of the crank web. It also gives the direct

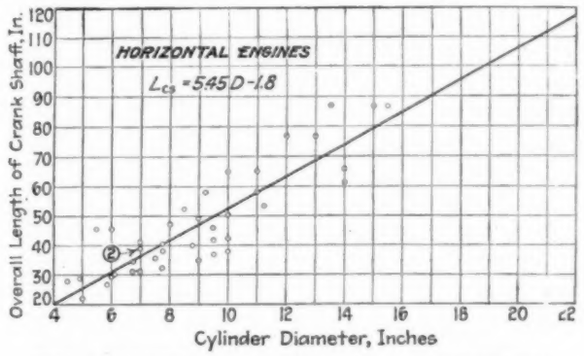


FIG. 17. OVERALL LENGTH OF CRANKSHAFTS

compression, S_c, in the web computed from equation (18):

$$S_c = \frac{0.7854\ D^2\ .\ P_m}{2\ .\ A_{cw}} \qquad (18)$$

where

D = Cylinder diameter;
P_m = Maximum explosion pressure;
A_{cw} = Area crank web

for the maximum explosion pressures used in Tables 1 and 2. The fiber stress due to bending is computed from the following equation:

$$S_b = \frac{2.36\ P_m\ .\ D^2\ .\ e}{W_{cw}\ .\ T_{cw}^3} \qquad (19)$$

where

D = Cylinder diameter;
P_m = Explosion pressure;
W_{cw} = Equation (12);
T_{cw} = Equation (11);
e = Fig. 1.

The maximum fiber stress in the crank web, S_{cw}, is equal to the sum of S_c and S_b and is the final quantity in Table 1.

Accidents and Safeguards in Great Britain

By I. W. Chubb

The annual report of the chief inspector of factories and workshops in the United Kingdom for the year 1914 has only just been issued. The period under review precludes it from dealing at any length with one of the most notable of the developments in engineering employment, namely, the remarkably extended use of the labor of women. Not only are they being employed for shell production on practically all the machining processes with which men have been associated, but under certain official pressure they have been engaged on the simpler work of the machine-tool shop. This subject will, one imagines, be considered at greater length in the report for 1915, where again the effect of continued overtime on the quantity and quality of the work produced may also be discussed more fully.

The report for 1914 deals to some extent with this subject, for an essay on emergency overtime by one of the superintending inspectors, after discussing the various branches of industry which have been under special stress, again shows that production greatly falls off after long spells of overtime. Many firms have concluded that maximum output is obtained in the ordinary statutory hours; others too agree to reduction when they learn, as they do quickly, that the physical capacity of their workers had been overestimated. In short a fairly general tendency has been shown where possible to reduce overtime, and the conclusion, which is certainly old as far as Great Britain is concerned, is that "while long and even excessive hours can be worked with advantage for short periods, continued overtime, if not kept within proper limits, soon fails in its object and ceases to aid production." The limits of course vary according to the nature of the work.

With regard to accidents, a large proportion of these continue to be due to carelessness of workpeople. Although during the year specified the total number of accidents reported was 10.5 per cent. less and the fatalities were in number 22 less than in the previous year, nevertheless the ordinary industry of the country involved something like 159,000 casualties, while many minor accidents are known to go unreported, several prosecutions being taken for neglect. Engineers and makers of machine tools seem to be satisfying the inspectors more readily on such points as the design and fitting of guards or fences.

The report in its scope concerns almost the whole of British industry; consequently it cannot be dealt with fully. We turn merely to machine tools and engineering work-shop matters. Here again, while lathes cause more accidents than any other type of machine tool, drilling machines are almost as prolific. As is pointed out, it is impossible to guard the drill itself, and the jamming of the tool in the hole often causes the work to swing, leading to many personal injuries. As to jigs, the inspectors suggest that as these are rarely fastened to the table their swinging should be prevented by means of strips. The guarding of certain turret-lathe headstocks is also criticized in cases where the bar projects from the head, the length in several instances exceeding that protected by the guard. U-shaped sheets of metal hinged and interlocked with the driving system or with the chuck are suggested. Few lathe accidents are now due to unguarded wheels, and the main causes are grouped as follows: (1) Traps between the work and tool, (2) flying cuttings or turnings, (3) projections on faceplates and chucks, (4) driving dogs and carriers, (5) shifting belts on cone pulleys. The inspectors, however, bear witness to the safety of the modern lathe as compared with the old-fashioned type. For millers, after a considerable struggle with engineering firms, the British Home Office through its inspectors compelled the use of guards on the cutters. Such accidents as now occur are found to be due to badly adjusted guards or to the negligence of workpeople, the 34 accidents in the Coventry district, for example, being practically every one due to attempts to remove cuttings with the fingers instead of using brushes.

Double-Hand Levers on Presses Are Not Perfect Safeguards

As to power presses, double-hand levers have not proved perfect safety contrivances, for out of 24 accidents with such presses 22 were due to the presses repeating. Before long, automatic guards will apparently alone satisfy inspectors, who report progress during the year in the design of guards of this character, the guards withdrawing "the worker's hand from the danger zone whenever the plunger ram is depressed, either intentionally in the manufacturing process, or accidentally as in the case of repeating." Referring to double-hand presses, a woman who met with an accident had attached the disconnected treadle to the starting lever, leaving the right hand free. As to slow-moving presses, in one case the plunger took six seconds to descend and the operator, after depressing the two handles, tried to adjust the metal under the tool. In some instances other workers, talking to the operator, accidentally leaned on one of the handles, causing the plunger to descend, and in Edinburgh the trick has been learned, unfortunately in more than one case, of starting the press by putting a leg over one lever, leaving one hand free. Inspectors foreshadow a considerable increase in the use of automatic machinery for metal-stamping purposes.

The inspectors are pressing for the use of perches for belts that are loose on revolving shafts, the perch to be used for replacing the belts and to act both as a shafting safeguard and as a belt economizer. The fencing of overhead belts is also attracting notice. In one inspection division alone, 40 accidents to operatives were due to broken belts in cotton mills. Belt shippers get introduced comparatively slowly into Great Britain, and the use of the hand for the purpose is a very old practice. It led, however, to 34 serious accidents in Lancashire cotton mills alone. One method that has been found to lead to immunity from accidents in sawmills is noted, every worker of whatever age having when engaged "to subscribe to a set of safety rules, with a certain amount of ceremony. . . . Each worker's signature to the rules is duly attested by a witness, and each person is made to feel that he is legally bound to comply with these rules and avoid any form of danger." This sawmill, which employs more than 100 people, has 12 saw benches, a number of planing and molding machines and other woodworking plant, and the methods of fencing are no better than in other similar mills where accidents frequently occur; yet in this particular sawmill no accident has happened since 1908.

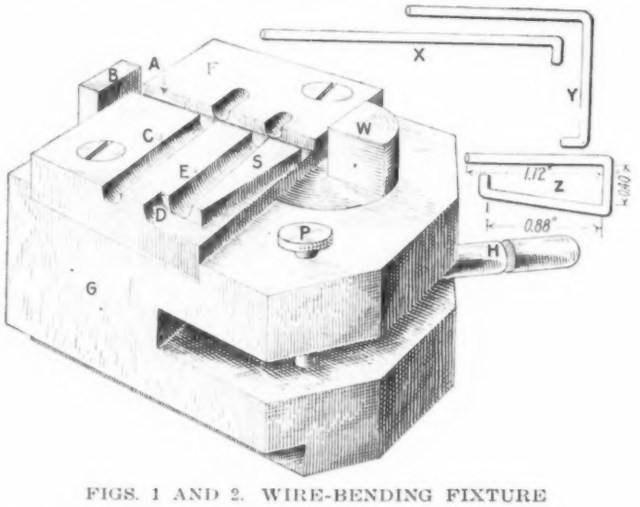
Wire-Bending Fixture

By George P. Breitschmidt

The sketch shows a machine part of $\frac{3}{32}$-in. music wire which requires three operations to make, all performed, however, on a single fixture and hand operated as illustrated.

Extreme simplicity and low cost, together with rapid production at a very low piece rate (for this character of work can be done by boys or any unskilled labor), will doubtless recommend this type of fixture over its rival, the press tool.

The operation of the fixture is as follows: Cut the wire to a length of $2\frac{13}{16}$ in.; place it in slot *A* against the stop *B* and draw the handle *H* forward until it stops



FIGS. 1 AND 2. WIRE-BENDING FIXTURE

against the knurled pin *P*—which completes the first bend.

Place the wire in the fixture so that the short bent end lies in the slot *C*; remove the knurled pin *P*; proceed as in the first operation until the wiper *W* brings up on the surface *S*—completing the second operation.

Place the bent wire in the fixture so that the short bent end lies in the clearance cut *D*, with the rest of the wire in slots *E* and *A*; proceed as in the second operation, and the wire is given its final bend.

The various bends and the completed wires are also shown. The base of the fixture *G* is made of cast iron. Plate *F* and the wiper *W* are made of hardened tool steel. The base is milled on the bottom with two L cuts.

Developments in Machine-Shop Equipment in 1915

By L. P. Alford

SYNOPSIS—The influence of the present European war upon the development of machine-shop equipment is strikingly emphasized by these figures; 15 per cent. of all the new-equipment items published this year related to machine tools and devices for producing munitions; 25 per cent. of the machine tools developed were brought out particularly for the manufacture of war materials. The year's record is one of the greatest in our history, being exceeded in quantity by the years 1911 and 1914 only. It has been essentially a year of simple machines, only one automatic having been put on the market.

With the close of 1915 ends the most interesting single year, as regards its departure from the expected, in the development of machine-shop equipment that this country has ever known. The record in a striking way shows the great influence of the European war upon our basic American industry. It is possible that some of the normally strong tendencies in our mechanical advancement will be permanently turned aside. Already the trend of machine-tool progress, as indicated by the contrasting record of 1914, has been completely sidetracked, and the natural restraining effect of rushing business on new developments has been to a great extent overcome. Another year or two must pass by before we will know what the final effects will be.

The most important trends of the developments in machine-shop equipment of the year 1914 summarize as follows: The use of higher cutting speeds, finer unit feeds and greater quantities of cutting lubricants; the increasing application of jigs, fixtures and holding devices that can be operated in a minimum time; the construction of highly organized automatic machines, performing a number of successive operations and suitable to be tended by unskilled labor.

In contrast, only one automatic machine was put on the market during 1915, and no further departures from current practice by using high speeds have been made. This record shows that the decided trends of the year 1914 have not been followed up. Furthermore, the pressure of production, in which time is the essence, has brought about the development of simple machines, each performing a single or short series of operations, capable of being tended by unskilled or slightly skilled labor, the whole arranged to produce the maximum output per unit of time.

Departures from Trends of the Past Years

The experience of the past in regard to the number of new machine-shop equipment items put on the market is that the maxima are produced in years of slack business. So if normal influences had governed the year 1915, we should expect the total for the year to be very low. As a matter of fact, this total nearly reaches the second largest in the history of American machinery building, 1911, and is greatly exceeded only by the preceding year, 1914. It must be remembered that the year 1911 covered a period of poor business and that during the first three-quarters of 1914 business was far from satisfactory. By contrast, American machine shops have never before had as much work on their hands as during the year 1915. Thus in this direction also the influence of the European war has been to upset the natural trend of our machine-tool and machine-shop appliance progress.

To show the relative number of new developments year by year for the past five years, Table 1 has been prepared. The data are taken from the records of the *American Machinist* and fairly present a complete picture of American machine-tool building developments. As a fixed editorial policy, a persistent effort is made to show and describe every new machine tool and appliance in the field. This is vital news of the industry and marks its advancement and tendencies. Practically all articles of this kind are illustrated, many having more than one view, as is indicated by a comparison of the total number of items for each year and the corresponding total number of illustrations.

A comparison of the totals in Table 1 shows that the year 1915 ranks alongside 1911 in reaching next to the highest record. The year 1914 was a banner year, with a total of 503 items, while 1911 had 437 and 1915 practically the same number, 425. In the interest of accuracy, it must be pointed out, however, that this year's record only slightly exceeds that of the year 1913.

TABLE 1. MACHINE-SHOP EQUIPMENT DEVELOPMENTS FOR YEARS 1911 TO 1915

Year	Items of New Shop Equipment shown in the "American Machinist"	Number of Pages Devoted to These Items	Number of Illustrations Used in These Items		
			Halftones	Line cuts	Total
1911	437	163	458	52	510
1912	375	144	406	70	476
1913	399	186	473	25	498
1914	503	269	606	88	694
1915	425	206	475	52	527

Detailed Analysis of the Record of 1915

A detailed analysis of the year 1915 is given in Table 2, which also shows the corresponding items for the year 1914. In only three cases does the record of 1915 exceed that of the year before. These cases comprise lathes, with 45 new machines brought out last year against 33 the year before; miscellaneous machines and appliances, with 101 against 86; and gear cutters, 10 against 9. The first two items begin to give us a hint as to where the war has influenced machine-tool development.

But before analyzing in detail the "war machines," it is wise to amplify and explain to some extent the totals for each one of the classes in Table 2.

Automatic Machines—In this class is only one machine, a six-spindle screw machine. The drop from ten machines in 1914 to a single one in 1915 is one of the striking features of the present year's development. It shows how strongly the trend has been toward simple machines, due to the stress of rapid mass production of war materials.

Boring Machines and Boring Mills—The eight machines in this class comprise one horizontal boring machine, one

special cylinder borer and six boring mills. Of the latter there were one 4-ft., two 5-ft., two 6-ft. and one 7-ft.

Drilling Machines—Nearly one-third of the drilling-machine developments were in small portable devices driven by electricity, compressed air or flexible shafts. In all there were 11 of these small machines. The other 27 making up the total of 38 divide as follows: Heavy vertical machines, 5; light vertical, 4; multiple-spindle vertical, 6; radial, 5; sensitive, 3; special, 2; bench, 1; post, 1.

Gear Cutters, Grinders, Lathes, Attachments, Millers and Miscellaneous

Gear Cutters—The 10 machines in this class are one each of the following kinds: Rack cutter, herringbone and spur-gear planer; bevel-gear shaper, spur-gear shaper, automatic gear cutter, special bevel-gear roughing machine, bevel-gear generator, worm-gear hobber, spur-gear planer and small universal gear cutter.

Grinders—The 36 machines in this class group into nine kinds, as follows: Cutter and tool, 7; cylindrical, 4; surface, 4; disk, 3; vertical, 2; tool-post, 2; universal, 1; plain, 1; special, 12.

Lathes—The 45 lathes group into 17 sizes and kinds, as follows: 14-in., 1; 16-in., 4; 17-in., 3; 18-in., 7; 19-in., 2; 20-in., 3; 22-in., 1; 24-in., 3; 26-in., 4; 27-in., 1; 30-in., 1; 32-in., 1; 36-in., 1; 38-in., 1; speed, 1; shell-turning, 7; cartridge-case turning, 1; hand-screw machine, 1; special, 2. One of the 18-in. is for chucking shells, and one of the 24-in. is provided with a turret.

Machine-Tool Attachments—The 17 separate attachments in this class divide as follows: Lathe, 5; drilling-machine, 4; miller, 3; tapping, 1; press, 2; boring-machine, 1; grinder, 1.

Millers—The 18 millers group as follows: Planer type, 3; knee and column type, 3; hand, 2; thread, 1; Lincoln, 1; vertical, 2; profile, 1; special, 5.

Miscellaneous Machines and Appliances—The 104 items in this classification cover a wide range of miscellaneous machines, tools, devices and appliances. Of these, 18 were designed for use in making war materials. Of the balance, 37 divided into eight kinds, as follows: Shop trucks, 6; electric welding and soldering machines, 6; furnaces, 5; oxyacetylene apparatus and torches, 5; filing machines, 4; friction clutches and countershafts, 4; vises, 4; polishing machine, 3. The remaining 49 are one of a kind and difficult to arrange in general groups.

Planers and Slotters, Hammers, Presses, Shapers, Supplies, Saws

Planers and Slotters—The two items under this class are one 48-in. by 24-in. by 20-ft. planer and one 5-in. stroke slotter.

Power Hammers—The single item under this classification is a motor-driven power hammer.

Punches, Presses and Shears—This class includes 42 machines for hot and cold forging, bending, and the working of sheet metal. Eight were developed particularly for manufacturing war material. The largest single item is for forging presses, of which there were five.

Shapers—The two items in this class comprise one combination toolroom shaper and miller, and a shaper with a new feed mechanism.

Small Tools and Gages—In this class are placed machinists' measuring tools, small tools and cutters of all kinds, indicators, testing devices and gages, and indicating and recording instruments such as pyrometers and revolution counters. The total is 71.

Supplies and Parts—In this class are die castings, cast-steel dies, bearings, grease cups, reduction gears, machine-tool guards and the like, and the total number of items is 14.

Bolt, Nut and Pipe-Threading and Cutting Machines—The single item in this class is a pipe threader.

Tapping Machines—The five machines in this class comprise one automatic nut tapper, one multiple-spindle tapper and three plain tapping machines.

Cold, Band and Hacksaws—This class includes four cold saws, three hacksaws, two metal band saws and one swing saw, a total of 10 machines.

A Study of the "War Machines" of 1915

A detailed study of the individual items entering into the make-up of Table 2 shows that 68 are of machines and a few devices either especially designed and built or particularly adapted to the manufacture of munitions. It is probable that there are others, which include machines and appliances that have also been largely adapted in this field but which are in the nature of general machine-shop

TABLE 2. COMPARISON OF MACHINE-SHOP EQUIPMENT DEVELOPMENTS, 1914 AND 1915

Kind	Number of Items Published 1914	1915
Automatic machines	10	1
Bolt, nut and pipe threading and cutting	6	1
Boring machines and boring mills	18	8
Cold, band and hack saws	12	10
Drilling machines	53	38
Gear cutters	9	10
Grinders	42	36
Lathes	33	45
Machine-tool attachments, separate	—	17
Millers	21	18
Miscellaneous machines and apparatus	86	104
Planers and slotters	11	2
Power hammers	2	1
Punches, presses and shears	39	42
Shapers	5	2
Small tools and gages	118	71
Supplies and parts	29	14
Tapping machines	9	5
	503	425

equipment and for that reason cannot be particularly identified with munition making. It is also undoubtedly true that many machines have been developed—particularly special and single-purpose machines—which thus far have not been put upon the market, or at least have not been given for publicity. During the year 1916 many of these will be presented.

The 68 items mentioned in the preceding paragraph detail as follows: Lathes—18-in., 7; 19-in., 2; 20-in., 3; 22-in., 1; 24-in., 3; 26-in., 4; 27-in., 1; 30-in., 1; 32-in., 1; 38-in., 1; shell-turning, 7; cartridge-case turning, 1; a total of 32.

Of the shell-turning lathes, one was special, having five turning positions, and it was developed primarily for turning shrapnel cases; two were for undercutting and waving the recess for the copper bands of shells; one was for turning the copper band itself; and four were special simple heavy lathes developed for shell turning and no other work.

Grinders—Two cylindrical grinders were especially built for the grinding of the outside of shrapnel-shell cases and projectiles, and two disk grinders for shell bases.

Millers—One special miller was made for surfacing the bases of shells.

Drilling Machines—One sensitive drilling machine with three spindles and a jig for drilling several holes simultaneously in fuse parts was brought out.

Punches, Presses and Shears—The eight machines in this group of "war machines" comprise two shell-forging presses, five shell-banding presses and one cartridge-case heading press.

Miscellaneous Machines and Appliances—In this subclass are 18 machines described as especially built for the manufacture of munitions. They include one centering machine for gun forgings, one rifling machine for gun barrels, nine cutting-off machines for shell blanks, one cutting-off machine for shell copper bands, two marking machines for shells, one shell-painting machine, one shell-baking machine and two for making wooden shipping cases for shells.

Machine-Tool Attachments—One dial feed press attachment was brought out for shells.

Gages and Small Tools—In this subclass are one special micrometer to be used in measuring the thickness of bullet jackets, one collapsible tap, and one special die head for threading the noses of shells.

Facts That May Govern the Trend During 1916

It is of course impossible to outline with any degree of certainty the probable trend of development in an industry that has such disturbed conditions as now exist in machine-shop equipment building. But a few facts can be pointed out with profit. Naturally the year just closing has brought out the simpler machines and simpler appliances, because these are more quickly and easily developed and perfected than special machines and automatics. The fact that only one new automatic has been put on the market does not mean that automatics have not been under construction, but does mean that the period has been too short to perfect them. The automatics that have been used up to the present time in making munitions were those that had already been through the development stage and had reached their period of success before the war.

It is also a fact that many special machines, particularly for the manufacture of shells and fuse and primer parts, have been and are being now designed and built. It is likewise true that development is also going on in single-purpose machines, designed for only one operation, or one major operation and its natural subdivisions on one particular size of shell or fuse or detonator part. Thus it is reasonable to expect that the year 1916 will give us as new machine-shop developments a large number of "war machines." These will not only include simple, regular and plain machine tools and familiar attachments and devices, but will also comprehend some of the more elaborate, highly organized special and single-purpose machines.

A Tribute to American Machine Designers

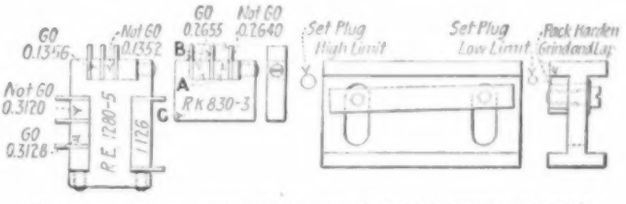
Undoubtedly the history of machine-tool development during the years 1915 and 1916 should be made a most careful permanent record. It will furnish a wealth of valuable information to this nation or any other nation when faced by the calamity of war. It also has a direct bearing upon the solution of the problem of preparedness, whether in this country or in any other. Comments made by officials of foreign governments in this country lead one to believe that the quality of American munitions is second to none produced in the world today. If this is generally true, it is surely a high tribute to the ingenuity, skill and business ability of American designers and machine-tool builders. Seventeen months ago this country knew nothing about the manufacture of any kind of war material. During that brief period our industries have been mobilized on voluntarily accepted orders, machining methods and devices have been designed and built, and production brought up to a huge quantity and with a satisfactory quality. This development shows the force and versatility of the American machine-building industry.

Inspecting Parts to Close Limits

By E. Estwing

In interchangeable manufacturing part inspection is as necessary as toolmaking, and like toolmaking may be allowed to be a heavy expense and bother instead of a good investment. One way to inspect is to have a central inspecting room where the work is thoroughly tested with expensive gages before entering the finished stores. This is the method of locking the barn door after the horse has been stolen. It is the most imposing at first sight, but is really the most expensive and least efficient because the spoiled work has been completed at as much cost as the good pieces. If any are repaired before they are passed, they may be much more expensive than good ones when the repair cost and overhead expense are included.

The following method of inspection has been found to secure the best results where the limits are close. Ma-



FIGS. 1 AND 2. TWO KINDS OF INSPECTING GAGES

terial is purchased to a special degree of accuracy and composition wherever that will make fewer or less expensive manufacturing operations and is inspected before acceptance. The source of a great deal of expense and trouble comes from the fact that purchasing agents as a rule do not have any practical knowledge of working the materials they buy and are constantly changing the source of supply or grade in order to keep to the rock bottom price of raw material. This is likely at any time to bring into the shop sheet metal that will crack in bending or drawing or will vary too much in thickness, screw stock that will not machine smooth, bar steel and castings varying in hardness so as to make formed-cutter operations very expensive and other troubles that are avoided by placing the raw-stock inspection in the hands of experts who realize the importance of the work.

The most important steps in inspection are to provide gages or other means of inspection with the tools when starting any operation, to have the inspector check the work before the operator is allowed to start and to tell the operators what signs to look out for, such as increase of smoke from cutting tools, chatter, squeaking, hard feeding, etc., which indicate that something is not as it should be. It is important to instruct the operators to use the same touch as the inspector uses and

which agrees with the shop standards. (A difference in touch of 0.0005 in. is common.)

All measuring tools must be kept true by a gage-maker who does this work under the inspection department. He has a tickler file of all such tools used and makes regular inspections, adjustments or repairs.

It is surprising to see how fast a gage wears if used constantly, especially on grinding and cast-iron work. The gage in Fig. 1 was designed to lower the upkeep cost and is used extensively and with satisfaction. The block *C* and parts *B* are made in lots to liberal limits. The spacers *A* are made to exact lengths, and as the wear is on *B*, these parts are taken out when worn, trued up on a grinder all at one time, smoothed on a lap and put back in place.

Fig. 2 shows a useful device for gaging a small or temporary lot of parts. When set to limit it is more reliable in the hands of girls than a micrometer. The construction needs no explanation.

Where the limits are less than 0.002 in., separate working and inspection limits are provided because an outside diameter will increase and an inside diameter decrease as the cutting edge on the tool wears, because the hard touch of the operator when gaging tends to make these same changes and because the change during heat-treatment affects the sizes in the same directions. White nickeling adds about 0.0005 in. to each surface. This affects diameters to an important degree in the same directions as does the wear of tools. Therefore the workings limits are lower than the inspection limits for outside diameters or outside milled surfaces and higher for inside dimensions.

If the defective pieces in any lot are not over a fixed percentage, the lot is sent into stores without gaging. This allowable percentage is the number of pieces the assembler can replace for the cost of inspecting 100 pieces. For instance, if the cost of inspecting 100 pieces is 5c. and the assemblers can replace three pieces for 5c., it would be a loss of money to hold up the production while inspecting any lot where there are not more than three defective pieces in 100. Thus 3 per cent. is fixed as the allowable percentage of defectives for that part.

Every lot is checked by girls before being sent to stores by gaging 100 pieces. If the allowance is 3 per cent. and not more than three bad are found, the lot is sent along. If more than three bad are found, 200 more are gaged. If the average number of bad out of the 300 is not over 3 per cent., the lot is sent to stores, but if over 3 per cent., every piece is inspected and the cost charged against the responsible department. These points on inspection summarize as:

1. A thorough raw-stock inspection before accepting material.

2. An inspector's check on every job before starting the operator on it.

3. An inspection of all measuring tools to keep them adjusted to the same standard and instruction of the operator to use them right.

4. A system of separating working and inspection limits to allow for wear in the tools, changes in heat-treatment and white nickeling.

5. The use of "good" and "defective" pans on machine work to save inspection.[1]

6. A fixed percentage of allowable defectives for each part to save inspection labor and uncertainty.

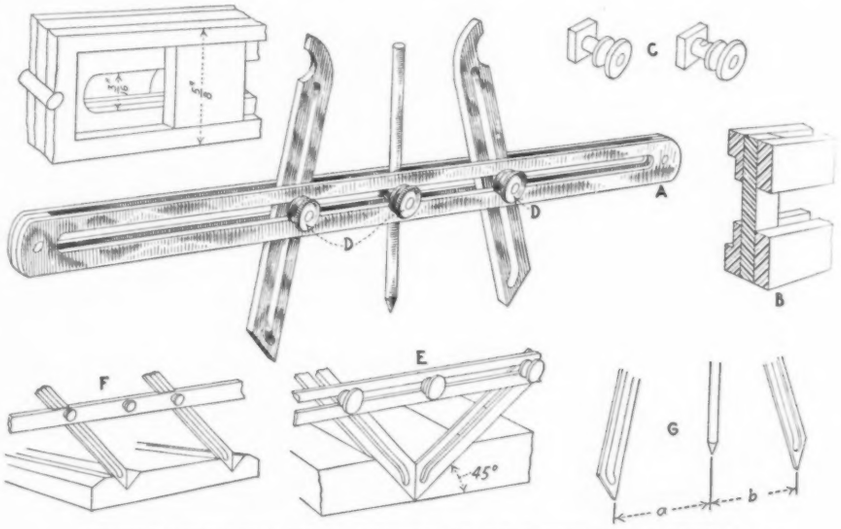
Combination Caliper and Gage for Various Purposes

By G. H. Walker

The illustration shows a combination gage which I made several years ago and which has proved extremely useful in many kinds of work. It consists primarily of the bar *A*, which is built up of two strips held apart by pieces $\frac{1}{16}$ in. thick at each end. An idea of the cross-section may be had at *B*. One side has a slot $\frac{3}{16}$ in. wide and the other a recess about $\frac{3}{8}$ in. wide for a depth of $\frac{3}{64}$ in., the whole bar being $\frac{5}{8}$ in. in width. The front section is only $\frac{1}{32}$ in. thick, while the back is $\frac{5}{64}$-in. stock.

The wide slot serves to hold the square locating nuts *C* in the wide part of the slot on the back plate. These nuts should come flush for greater convenience in handling.

Three thumbscrews *D* allow easy adjustment or hold either the slotted blades or the center rod in position. This center rod fits in a slot which always holds it in the center and at right angles to the body of the gage when in use. The other blades are a trifle less than $\frac{1}{16}$ in. thick, so as to slide easily in the slot, and as can be seen, have one end fitted for use as inside or outside calipers, while the other end is beveled to 45 deg. This allows the two blades to be used as a square as shown at *E*, or they can be set for measuring the angles of V's or planed ways as at *F*. The use of the center rod is shown at *G*, where the two blades are set at equal distances from the center rod. This tool will be found useful as a tram, as a bevel gage, depth gage, straight edge or square. It has proved especially useful in roll turning, in which I have used it for a number of years.



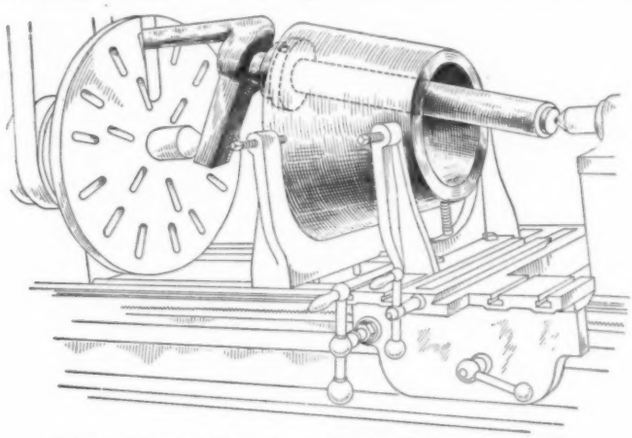
COMBINATION CALIPER AND GAGE OF WIDE APPLICATION

[1] See "Manufacturing to Close Limits," "American Machinist," Vol. 43, p. 1034.

Letters from Practical Men

Boring Fixture for Large Tapers

The accompanying illustration shows a device that we have used to advantage in boring taper holes in large bushings. The bushing in question was 15 in. and 12 in.



LATHE FIXTURE FOR BORING LARGE TAPERS

in diameter by 16 in. long and had a wall ½ in. thick. This bar is 3 in. in diameter by 3½ ft. long and self-feeding. The end of the bar is offset to suit the taper of the bushing. Only one tool is used.

Charlotte, N. C. JOHN F. GORDON.

Time for Cylinder Grinding

The time for grinding automobile cylinders and the chucking time vary, of course, with the type of cylinder to be handled, the amount of stock to be removed by grinding and the accuracy of the machine work when the cylinder comes to the grinding machine. It also depends naturally to a great extent on whether the cylinders are handled in quantities and on the skill of the operator.

Type of Cylinder	Size of Hole	Amount of Stock Removed, In.	Grinding Time, Including Time for Putting Work in Fixture and Removing
Single	3¼ x 6½	0.007	8 min.
4 en bloc.....	3¾ x 7¼	0.010	15 min. per hole
Single	4½ x 7½	0.010	18 min. each
2 en bloc.....	4½ x11	0.015	30 min. per hole
Single	10 x14	0.015	45 min. each

In order, however, to give some idea of the average grinding time on various holes on the cylinder grinder, a table compiled from data furnished by the Heald Machine Co., of Worcester, Mass., is given herewith.

New York, N. Y. ROBERT GRIMSHAW.

Making a Paper Cap

The cap shown in Fig. 1 is made of 0.022-in. thick paper moistened in hot water or steamed until the calender of the paper is softened so it will not tear.

In the construction of the die, Fig. 2, the blanking diameter *A* is seated on the steel shoe *B*, which in turn is seated on the cast-iron shoe *C* held in place with four screws *D*. The center piece *E* is of machine steel pressed in the shoe. The part *F* acts as a stripper with knockout pins *G* passing all the way through the center piece and rests on the plate *H*. The lower spring holds *H* in the position shown.

The blanking punch *J* is seated in the shoe *L*, held in place with four screws. The forming punch *K* also seats in the shoe *L*, and it is held in place by the blanking punch. The piercing punch is a sliding fit in the forming punch and is held with two screws. The knockout pad *M* is a sliding fit and is held with a screw as shown.

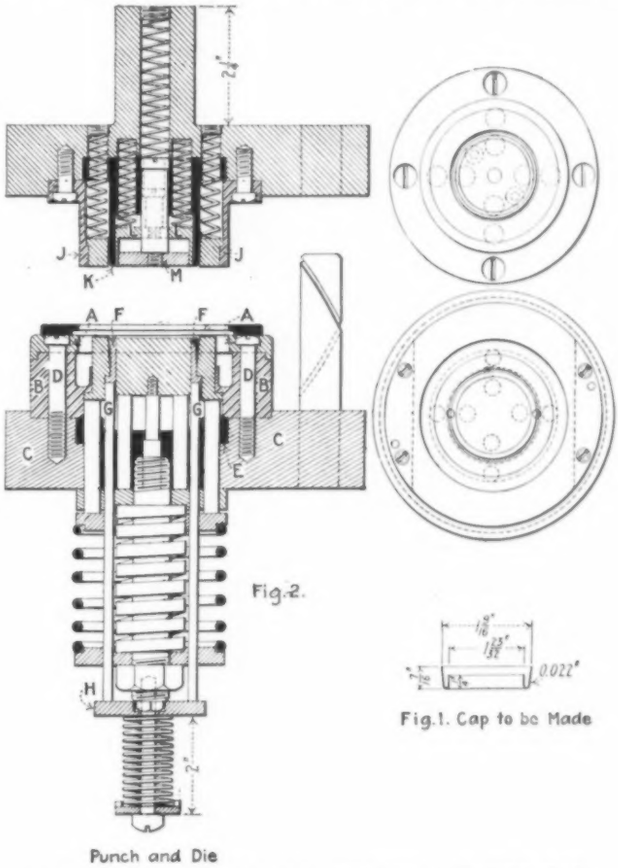


Fig. 1. Cap to be Made

FIGS. 1 AND 2. TOOLS FOR MAKING A PAPER CAP

The pressure pad *N* is a sliding fit in *J* so as to eliminate screws as much as possible and not weaken the shoe.

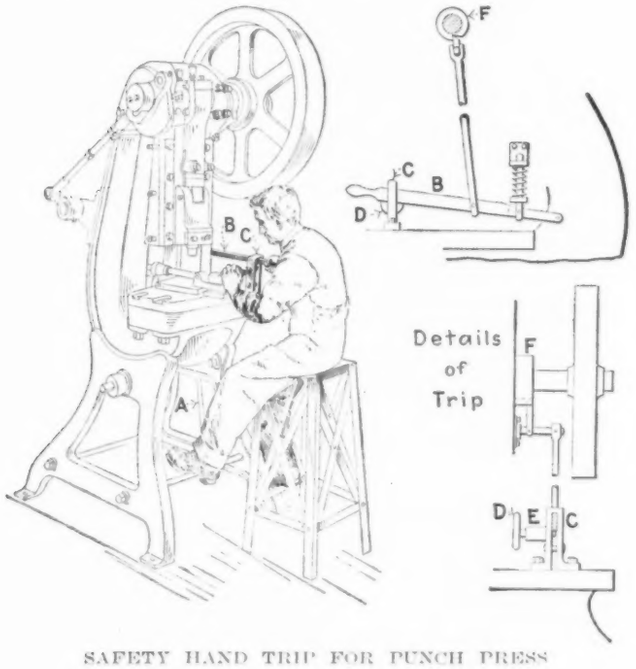
As the press descends the blanking punch cuts the blank, and the forming punch forms the inside of the cap. The pressure of the large spring is great enough to hold the forming die, but as soon as the piercing punch reaches its upper position, the forming die goes down; at the same time the outside forming die hits its lowest position. This finishes the outside of the cap, and in the meantime the pressure from the large spring *A* is so great that the punch with a cupped-out cutting edge goes through the paper. The knockout pad throws out the slug, and the pressure pad keeps the wrinkles out of the paper as much as possible. The stripper with a small spring pressure forces the cap out of the die.

Rahway, N. J. A. H. WADELL.

Safety Trip for Punch Press

The illustration shows a punch-press safety device operated by hand instead of by foot. Both hands of the operator must be engaged and out of the way of the plunger on its downward stroke. The device is being used successfully at our plant, without any decrease in production, on sizing caps for subsequent operations on automatic machines.

By disconnecting the foot-power linkage *A*, the hand lever *B* and the guide *C* are attached so that the lever *B* cannot be operated until the locking pin *D* is pulled out far enough with the left hand to permit the lever *B* to be



SAFETY HAND TRIP FOR PUNCH PRESS

pulled downward with the right hand. This releases the latch in the clutch *F* and allows a cycle of the press. After the piece to be sized has been placed in position under the plunger, the locking pin *D* can be released from the hand at the same instant that the lever *B* is started downward, which gives the operator the use of his left hand with which to place the next piece of work.

As lever *B* and locking pin *D* have tension springs, they are forced back into place when released from the hand; then the latch *F* engages and the locking pin *D* drops under lever *B*.

Ross Anderson.

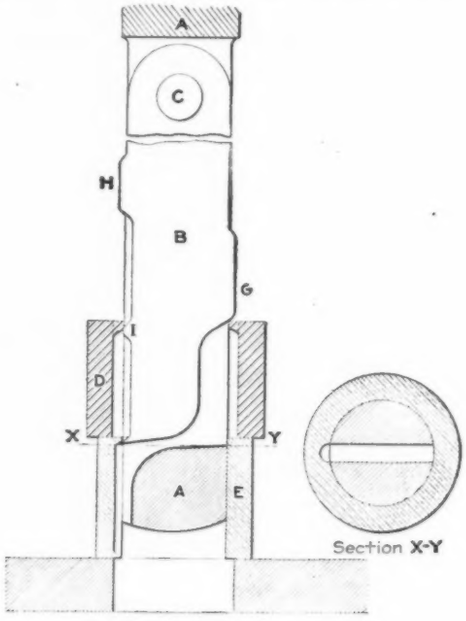
Bridgeville, Penn.

Oil-Groove Cutting Tool

The oil-groove cutting tool shown will be found very useful where many bearings having the same inside diameter are to be grooved or slotted for oil. No special machine is necessary. It simply requires a reciprocating motion from a press or some similar source.

The tool holder, or case *A*, is slotted in the center for the grooving tool *B*, which is pivoted at *C*. The tool must be made of the correct size and shape so that the guide *D* can control the action of the cutting point of the tool by means of the projections, or cams *G* and *H*.

The bearing to be grooved is shown at *E* and is supported by the arbor press table and held in position by the front end of the tool holder. As the tool is forced down, the tool point is prevented from cutting by the cam *I* until after the point has passed beyond the edge of the bearing *E*. Then the cam *G* begins forcing the cutting point into the bearing, and keeps its required



OIL-GROOVE CUTTING TOOL

depth until *G* passes the end of the bushing *D* and cam *H* forces the cutting point once more out of the bearing.

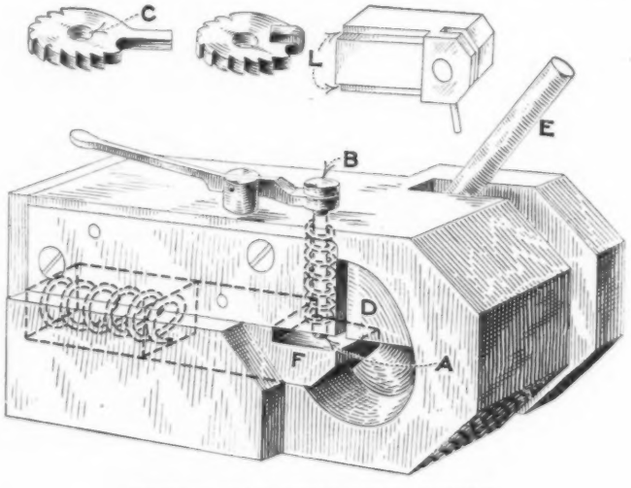
This is a simple little device, which can be used to advantage in many places.

Avenel, N. J. Adalbert O. Alexay.

Simple Ear-Bending Fixture

The accompanying views illustrate a hand-operated fixture by means of which an otherwise difficult operation became quite simple.

As will be seen from the sketch, the two milled surfaces *L* on the bottom of the fixture are for holding it in a



SIMPLE EAR-BENDING FIXTURE

bench vise, thus allowing the free use of both hands in placing the work and operating the device.

The complete operation is as follows: Place the work in groove *A*, locating it by the spring pin *B* at the hole *C*; then pull the wiper *D* by moving the handle *E* toward you, which starts the bend. As the handle *E* is drawn

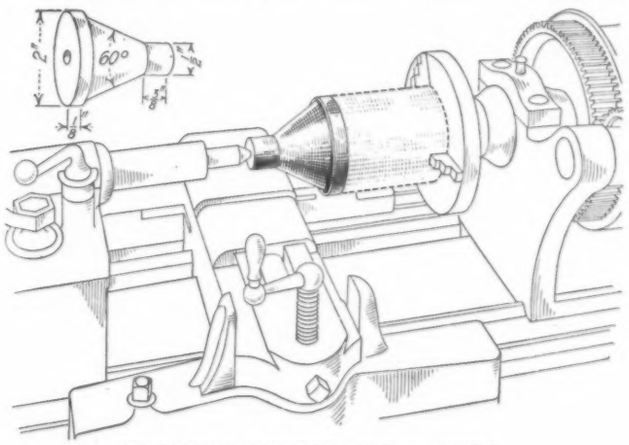
farther forward, the bent portion of the work strikes the movable jaw *F*, which recedes as the work advances, until the handle and wiper complete the movement and make the desired bend.

The operation consumes very little time, and this in addition to the small initial cost of the fixture will doubtless attract the attention of extensive users of press tools on this class of work.

Arlington, R. I. GEORGE P. BREITSCHMID.

Floating Center for Lathes

The illustration shows a center which has proved useful for lathe work. The tool should be made of steel hardened and ground to give the best results. The flat end is placed against the piece being machined in the chuck. The tail-stock point center is placed in the small



FLOATING CENTER FOR LATHES

end, which steadies the part being machined. This stops chattering, and especially so while performing cutting-off operations where the piece sticks out too far to be supported at the end. When machining the tubing the center should be reversed. H. S. MOLINEU.

San Diego, Calif.

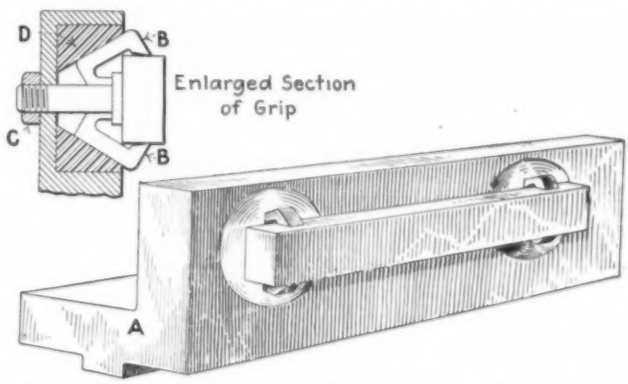
Drill and Punch Sizes for Standard Screws

The accompanying table gives standard sizes of A. S. M. E. screw threads for use in connection with typewriter, adding-machine work, etc., the tap sizes for drills for cast iron, brass, steel and silver and the body size drill for each size screw. Under the heading of "Punches" is given the diameter of the punch for piercing holes in sheet metal to be tapped and also to take the screw.

Hartford, Conn. MILLS E. WRIGHT.

Milling Attachment for Thin Cutter Blades

The illustration shows an attachment for milling thin cutter blades. The fixture consists of an angle plate *A*, through which are inserted two hooks *B*, which hold the work. By pulling up on the nut *C* the hooks draw back on the taper guides *D* and tighten on the work. To secure a



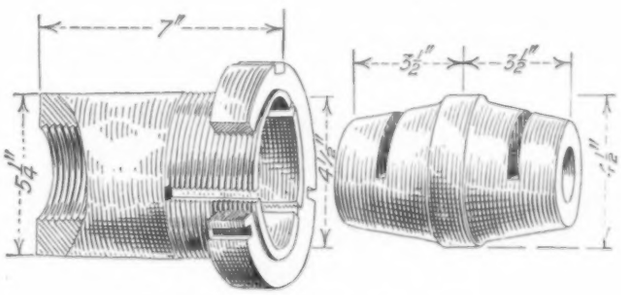
MILLING ATTACHMENT FOR THIN CUTTER BLADES

better hold, the points on the hooks which force down on the work are tapered. Blades as thin as $\frac{1}{16}$ in. can be milled with this fixture, depending on the length of the point of the hooks. The hooks and guides are made of tool steel hardened. FRED FRUHNER.

Milwaukee, Wis.

Boring Motor Bearings

The sketch shows a handy chuck for boring motor bearings. It consists of a steel sleeve bored and threaded at one end to screw on the lathe spindle. The other



CHUCK FOR MOTOR BEARINGS

end is bored to the same size as the outside diameter of the motor bearing, and three equally spaced slots, each 2½x¼ in., are cut as shown, to allow for compression. The outside diameter of this end is turned taper ¾ in. per foot

STANDARD SCREW SIZES (A. S. M. E.)

No.	Pitch	Outside Diam. Min.	Outside Diam. Max.	Pitch, Diam. Min.	Pitch, Diam. Max.	Root, Diam. Min.	Root, Diam. Max.	Tap Drill, Sizes Cast Iron	Tap Drill, Sizes Brass	Tap Drill, Sizes Steel	Tap Drill, Sizes Silver Metal	Body Drill	Punches Tap	Punches Body
												52		52
0	80	0.0572	0.0600	0.0505	0.0519	0.0410	0.0438	.....	.....	.....	.....	0.0635	.....	0.063
												48		48
1	72	0.0700	0.0730	0.0625	0.0640	0.0520	0.0550	.....	.....	.....	.....	0.076	.....	0.075
								49	51	50	51	43	50	43
2	64	0.0828	0.0860	0.0742	0.0759	0.0624	0.0657	0.073	0.067	0.070	0.067	0.089	0.069	0.088
								43	44	44	44	38	44	38
3	56	0.0955	0.0990	0.0857	0.0874	0.0721	0.0758	0.089	0.086	0.086	0.086	0.1015	0.085	0.101
								40	41	40	41	33	40	33
4	48	0.1082	0.1120	0.0966	0.0985	0.0808	0.0849	0.098	0.096	0.098	0.096	0.113	0.097	0.112
								34	35	35	35	30	34	30
5	40	0.1208	0.1250	0.1067	0.1088	0.0877	0.0925	0.110	0.110	0.110	0.110	0.1285	0.110	0.127
								31	32	32	32	28	32	25
6	36	0.1336	0.1380	0.1178	0.1200	0.0967	0.1019	0.120	0.116	0.116	0.116	0.1405	0.115	0.139
								28	29	28	29	19	28	19
8	36	0.1596	0.1690	0.1438	0.1460	0.1227	0.1279	0.140	0.136	0.140	0.136	0.166	0.139	0.164
								20	20	20	22	11	20	10
10	32	0.1853	0.1900	0.1674	0.1697	0.1437	0.1494	0.161	0.161	0.161	0.157	0.101	0.161	0.191
								13	14	13	14	2	13	2
12	28	0.2111	0.2160	0.1903	0.1928	0.1633	0.1696	0.185	0.182	0.185	0.182	0.221	0.185	0.219

and threaded eight threads per inch, on which is screwed by means of a spanner wrench a steel collar threaded taper to suit.

The bearing will center itself when inserted in this chuck and tapped lightly with a hammer while tightening the collar, allowing the bore, counterbores and radii to be machined accurately at one setting. Separate chucks may be made for different-sized bearings.

Catasauqua, Penn. EDWIN CHAPMAN.

A Drift-Hole Slotting Machine

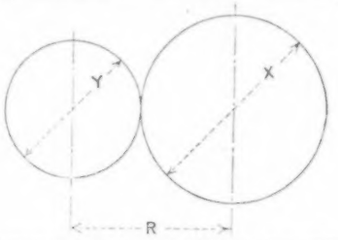
The methods by which drift holes are cut in machine spindles are almost innumerable. Many of the methods have been described in the *American Machinist* from time to time. The machine shown was made in the shop of the F. W. Lindgren Co., Rockford, Ill., for cutting the drift keyholes in drilling machine spindles. The spindle to be slotted has a taper plug placed in the shank hole and then it is mounted in the machine as shown at *A*, Fig. 1. The brackets, or pillow blocks, that hold the spindle are adjustable lengthwise of the bed when desired, but are clamped solidly while the machine is working. The slots are cut from opposite sides of the spindle at the same time, the opposing spindles working simultaneously and being fed in together by means of a right- and left-hand screw. The carriage on which the cutting spindles are mounted moves back and forth in slides, being given its reciprocating movement by means of a crank attached to the wormwheel *B*. The wormwheel is slotted on the side, so that the stroke of the crank may be varied to suit the lengths of slots to be cut. The drive is obtained from belt and pulley *C* through a worm *D*, which meshes with the wormwheel. The two cutting spindles are driven by separate belts, as shown.

The cutters are fed into the work at the beginning of each stroke, forward and backward. This is accomplished in this way: On the same shaft with the worm gear is a disk *E*, on the inner face of which are two cams like *F*. As the disk rotates, these cams in turn strike a short lever at *G* and cause the lever *H* to lift. Now, moving around the machine a little, we come to the view shown in Fig. 2. Here the end of lever *H* is shown at *I*. When in normal position the end of this lever rests against the stop *J* on the pulley *K* and prevents it from rotating, the small round belt *L* just slipping in the groove. There are two stops on this grooved pulley, to correspond to the two cams just mentioned, though the outer stop is not visible. When the cam rise causes the lever to lift, it rises above the stop on the pulley and allows the pulley to turn until the end of the lever strikes the other stop, when the round belt *L* again slips. As the grooved pulley is on the same shaft with the worm *M*, which meshes with the worm gear *N* on the feed screw, the intermittent-feed movement can be easily figured out. By using the indexing crank *O*, the feed screw may be turned at any time.

Cincinnati, Ohio. ETHAN VIALL.

Changing Gear Ratios Without Disturbing Centers

The following formulas may be used when it is desired to retain the gear centers and change the ratio of the gears. A diagrammatical illustration of a gear drive is



DIAGRAMMATICAL ILLUSTRATION OF GEAR DRIVE

shown in Fig. 1, the formula and its applications being as follows:

$$N + Y = 2\,R.$$

M to N = Ratio of gear to pinion.

$$2\,R \div M + N = S.$$

$$Y = S + N.$$

$$N = S + M.$$

Example:

$R = 9$. (M to $N = 2\frac{1}{2}$ to $1\frac{1}{2}$)

$18 \div (2\frac{1}{2} + 1\frac{1}{2}) = 4\frac{1}{2}$.

$Y = 4\frac{1}{2}'' \times 1\frac{1}{2} = 6.75''$.

$N = 4\frac{1}{2}'' \times 2\frac{1}{2} = 11.25''$.

$R = (6.75 + 11.25) \div 2 = 9''$.

Waterbury, Conn. JOHN H. GEDDES.

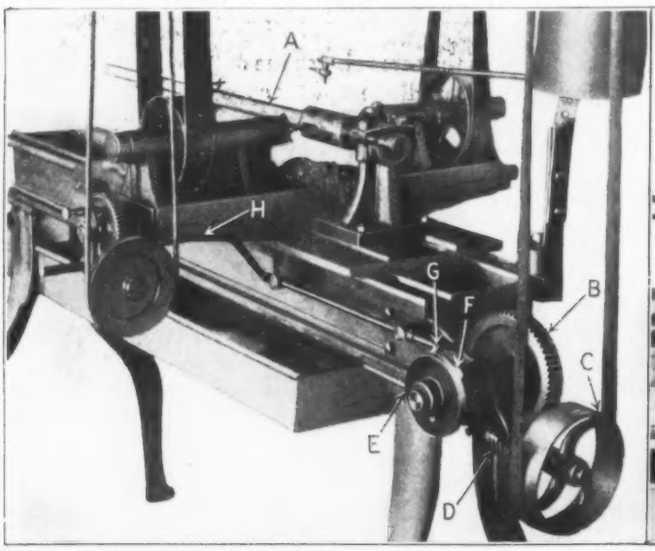


FIG. 1. A DRIFT-HOLE SLOTTING MACHINE

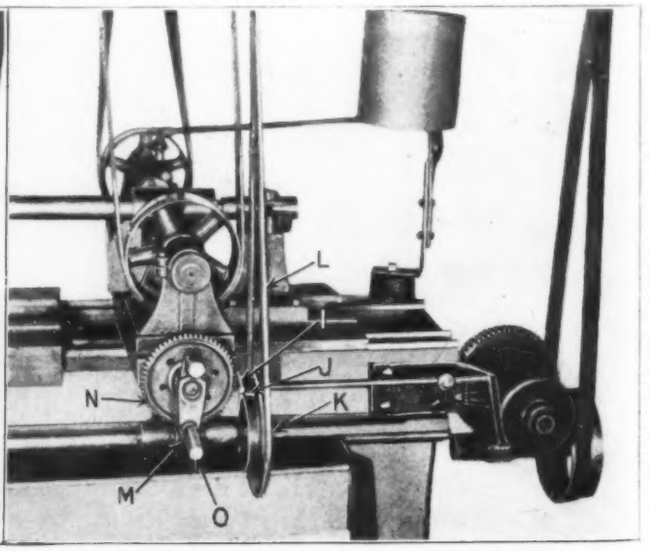


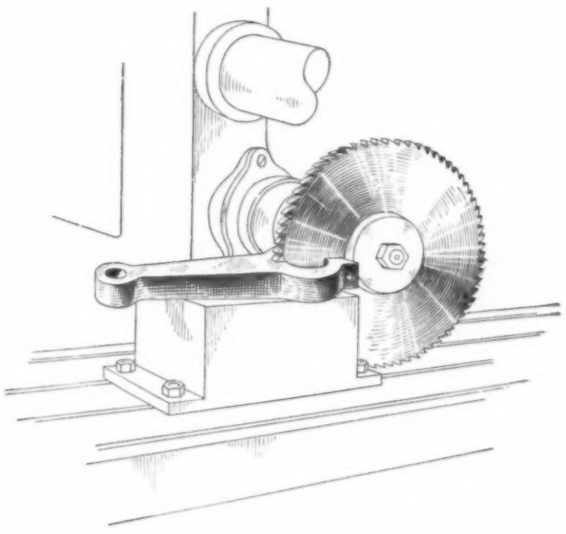
FIG. 2. DETAILS OF THE FEEDING MECHANISM

Discussion of Previous Question

Best Way To Do Certain Things

On page 936, Prof. John E. Sweet gives three examples of the best ways to do certain things. To quote him: "Another thing is to secure a rocker arm on a shaft. The best way is to put in a feather on a line with the arm, put on a boss for a grip-bolt opposite, split the hub, put a bolt through the boss and screw it up." From an engineering point of view I cannot improve his method but from the standpoint of economy and convenience, I can offer two or three suggestions.

Splitting the hub and milling the keyway can be done in one operation with the same saw, as shown herewith.



SAWING AND KEYWAYING ROCKER SHAFT IN ONE OPERATION

This results in manufacturing economy and is being done on a wholesale scale in the automobile industry.

A capscrew is often more convenient for gripping purposes than a bolt, for it requires only one wrench instead of two for screwing it up.

If a bolt is preferred to a capscrew, a shoulder on the boss to keep the head of the bolt from turning will be found a great convenience. M. V. TERRY.

Flint, Mich.

Mr. Sweet's article on page 936, Vol. 43, on the best way to do certain things, reminded me of several lines of shafting I had to remove and replace during some reconstruction work for the Anglo Newfoundland Development Co., of Grand Falls, Newfoundland. The particular thing of interest was a $6\frac{15}{16}$-in. shaft with couplings to be removed. The portable hydraulic press was rigged up to the job and pumped to its limit of 100 tons on a 6-in. ram, but the coupling never budged.

We tried assisting it with blows from rams, etc., but without success. Then we hit upon an idea that succeeded. We built a box inclosing the coupling, leaving two or three inches of space around the diameters of the coupling, but without reducing the pressure. We poured this box full of hot lead. The heat of the lead did the job—the coupling expanded and came off easily.

Canton, Mass. J. J. MCHENRY.

Spacing Grooves by Means of Lead Screw

On page 994 Mr. Limbrunner describes a method of spacing grooves on a roll by means of a lead screw.

The only objection to this method is the necessity of opening and closing the split nut to space each groove, also the possibility that the carriage might be inadvertently moved, thus destroying the alignment of the grooves. The following method is another used for this same class of work, and it has given excellent results.

Disengage the tumbler gears, attach a 96-tooth gear to the end of the lead screw and close the split nut. Then attach a flat pointer on the intermediate gear stud, the pointer being filed to the shape of a gear tooth and long enough to mesh in one tooth space when pressed against the 96-tooth gear. Having the center distance of the grooves, it is a very simple matter to figure out the index as follows:

$$\frac{\textit{Lead of screw}}{\textit{number of teeth in gear}} = \textit{Lead per tooth of gear.}$$

$$\frac{\textit{Center distance of groove}}{\textit{lead per tooth of gear}} = \textit{Number of teeth in index gear.}$$

By adjusting a pair of dividers to the number of gear spaces required, the indexing is done quickly with slight possibility of mistake. B. A. MILLER.

Wallingford, Conn.

Making Small Accurate Piercing Punches at Low Cost

I have noted a very good article on page 952, "Making Small Accurate Piercing Punches at Low Cost," by William Seitz. I was much pleased to see this, and can say that I know every word of it is correct, because I have been up to this dodge for a very long time, and all I had was a die to hold the wire while I headed it up.

I used this method on a contract to drill a lot of $\frac{3}{8}$-in. common bar iron. (You know that today common bar iron is sometimes steel.) Our contract was to drill with a $\frac{1}{4}$-in. drill and countersink $\frac{3}{4}$ in. half round. I made punches as described by Mr. Seitz, by taking $\frac{1}{4}$-in. drill rod, heading it up and cutting off to proper length, which was $3\frac{1}{4}$ in. We made a holder that fitted the nose piece of the power press and the drill rod, and allowed the rod to project $1\frac{1}{8}$ in. This holder was split, so that when I tightened up the press nose it would also tighten the little punch.

I did the punching with little trouble. The stripper did not fit the small punch, nor was there any guide to hold it in line with the die. This I think is a good record

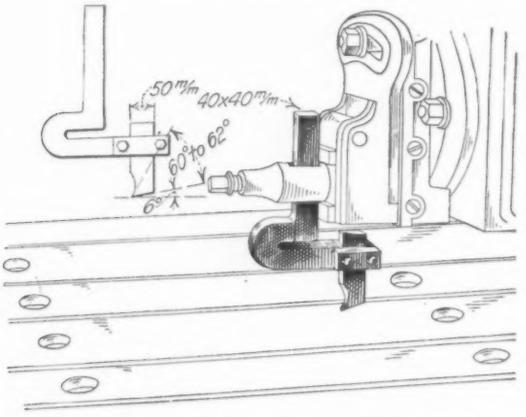
when you remember we punched through ⅜-in. stock. I found drill rod better than either Stubs steel or bar steel for the punches. F. W. LUNN.

Montreal, Canada.

Cutting Bar Stock on Planer

Fifteen days before I received a copy of "Shrapnel and Other War Material" I had fitted out a planer for cutting bar stock exactly like the illustration, Fig. 6, on page 9.

I place 18 bars of 1.10-m. length on the table and make two cuts in round stock 85 mm. in diameter. Placing the



SPRING PARTING TOOL FOR BAR STOCK

work on the machine, cutting and taking it off require 6 hr., which gives 54 pieces twice a day, or 108 pieces (12 hr. per day). As this method caused some trouble by injuring the cutting tools, I tried the use of a spring tool and obtained good results (see illustration). The width of the blade must not be thinner than 10 mm.

Paris, France. E. NAMOUR.

Whitworth Thread Data

A contribution on page 734, Vol. 43, raises a query as to why the Whitworth thread has an included angle of 55 deg.

As to the conditions prevailing before the introduction of the standard Whitworth thread and its universal adoption in the United Kingdom, I was recently privileged to gain information, which year by year is becoming rarer. A firm in London whose history goes back over a century was extending its premises, which are situated on the river side, and some sheds had to be demolished. Among the ancient materials laid bare by the demolition were a quantity of screw-cutting devices and the remains of the benches used by workmen long dead.

The interesting portion of the devices so discovered was some tons of taps of every shape and size. Casual comparison made plain the fact that not merely had no standard been employed, but apparently each mechanic had made his own screw-cutting tools according to his own ideas and that each workman had had his own standard, or want of standard. Literally no two taps were alike in pitch diameter, actual form of thread or of groove.

In the same works still stands in good condition lathe No. 9, Joseph Whitworth & Co., 1840. The conical journal bearings are in perfect condition. While this lathe was not actually in use when I was afforded the opportunity of looking around, I was informed that it had been used only a few months before.

But to revert to the threads and the manner in which the Whitworth variety came into being, the following extracts from the original paper presented by Sir Joseph Whitworth before the Institution of Civil Engineers in 1841 may help to solve the matter. Within ten years after the paper was read the system was in universal use, and as the purveyor of "screwing tackle," the author of the paper was then a wealthy man.

After citing the difficulties obvious from the existing want of uniformity and its consequence, and the variety and expense involved by differing threads, he goes on:

It is impossible to deduce a precise rule for the threads of screws from mechanical principles or from any number of experiments. On the other hand, the nature of the case is such that mere approximation would be unimportant, absolute identity of thread for a given diameter being indispensable.

There are three essential characters belonging to the screw thread, namely, pitch, depth and form. Each of these may be indefinitely modified independently of the others, and any clamp will more or less affect the several conditions of power, strength and durability. The selection of the thread is also affected by the mutual relation subsisting between the three constituent characters of pitch, depth and form. Each of these may be separately modified; but practically no one character can be determined irrespective of the others.

We find instead of that uniformity which is so desirable, a diversity so great as almost to discourage any hope of its removal. The only mode in which this could be attempted with any probability of success would be by a sort of compromise, all parties consenting to adopt a medium for the sake of common advantage. The average pitch and depth of the various threads used by the leading engineers would thus become the common standard, which would not only have the advantage of conciliating general concurrence, but would, in all probability, be nearer the true standard for practical purposes than any other.

An extensive collection was made of screw bolts from the principal workshops throughout England, and the average thread was carefully observed for different diameters.

Then follows the well-known table showing the number of threads per inch.

It will be remembered that the threads, of which the preceding table shows the average, are used in cast iron as well as wrought; and this circumstance has had its effect in rendering them coarser than they would have been if restricted to wrought iron.

The variation in depth among the different specimens was found to be greater proportionately than in pitch. The angle made by the sides of the thread will afford a convenient expression for the depth. The mean of the variations of this angle in 1-in. screws was found to be about 55 deg., and this was also pretty nearly the mean of the angle in screws of different diameters. As it is for various reasons desirable that the angle should be constant, more especially with reference to general uniformity of system, the angle of 55 deg. has been adopted throughout the entire scale. A constant proportion is thus established between the depth and the pitch of the thread.

In calculating the former, a deduction is to be made for the quantity rounded off, amounting to one-third of the whole depth—that is, one-sixth from the top and one-sixth from the bottom of the thread. Making this deduction it will be found that the angle of 55 deg. gives for the actual depth rather more than three-fifths and less than two-thirds of the pitch. The precaution of rounding off is adopted to prevent the injury which the thread of the screw, and that of the taps and dies, might sustain from accident.

The extracts given above are in the words of the originator of the system himself, than whom no more authentic authority could be quoted. The angle of the thread and the number of threads per inch were fixed by compromise, and nearly all subsequent standardization of engineering material has proceeded in a like manner. Compromise is a blissful word, and along its lines is the path of least resistance. A. L. HAAS.

London, S. W., England.

Editorials

Munition Making and Wages

Munitions are being made largely on piecework in American shops. Men with little or no mechanical skill are being employed on this work. The processes, methods and tools are as a rule highly developed and individual operations greatly simplified. There is tremendous pressure on everybody to get out a maximum output for each working day.

What is the effect of all this on wages? The question almost answers itself. Wages are high. Many men now engaged in making shells and other kinds of war material are earning more money each week than they would ordinarily get in three or four or even five weeks. To these men it is a golden harvest time. And the wiser ones will hold down their living expenses to a point close to the normal and build up a bank account against the coming rainy day, or for use later on in some long-dreamed-of business venture.

The desirability of saving a generous portion of these large wages cannot be urged too strongly. No one can tell how long the present piecework prices in munition manufacture will hold; no one can tell for how many months munitions will continue to be manufactured in the United States—but this we all know, the end will come some time. When that day does come, wages in machine shops will go back to their normal level. The daily and weekly wages now received in munition plants will no longer be earned. From stern necessity, living will have to come back to a scale in keeping with the current wages for each locality. That these changes in conditions may not bring hardship upon the men who are engaged in munition making today—and upon their families—such men should save a generous portion of the excess that they now earn. This course will lead to two things: It will keep the scale of living where it properly belongs, and it will provide a bank account that any man can use to advantage.

It has been pointed out that a readjustment of piecework prices on munition making may take place before the end of the war. Such a readjustment has already been put into effect in some shops. In one in particular the piece prices have been revised for every 100,000 shells produced. The justice of this is seen when we realize that the methods of manufacture—including changes in operations due to modifications in specifications, other changes due to improvements in the processes of manufacture, the introduction of new machine tools, improvement in cutting tools and the like—have continually shortened the time of manufacture and increased the output per machine and per man, per working hour. Thus a readjustment of the piece prices for each lot of 100,000 shells seems to be a natural and just proceeding.

Another side of this question concerns the men who are engaged on regular production at regular wages, yet are under the same roof and perhaps even in the same department with workers who are handsomely profiting from munition work. The future of the firm's business unquestionably depends upon the old hands who are turning out the regular line. After the war-material contracts are finished, the looms, printing presses, pumps, motors, typewriters or agricultural machinery must be made as before, to keep things going. A number of shops fully realizing this situation have adopted the plan of paying an increased bonus to the men on regular work during the war period.

This subject of munition making and wages cannot be dismissed without a reference to the position of the foreman. In many an American machine shop, workmen are now earning far more per week than the foreman who is directing them. Some grumbling is heard. Perhaps some of it is justified. In fact it seems very proper to ask if some bonus scheme should not be adopted whereby the foremen will profit in proportion to the added responsibility, increased hours and additional amount of profit being earned by their departments. But whenever the foreman's position is considered, the fact must not be overlooked that his position and wages are reasonably permanent, while the large present-day earnings of his men are temporary.

"War Machines" as a Term of Reproach

We have previously pointed out the dangers of rush work to the reputations of American machine-tool builders. This is being shown in many quarters of our own country as well as abroad. In fact "war machines" has become a nickname and a term of reproach in many shops.

Makers of munitions that in many cases require extreme accuracy are receiving lathes and other machines with spindles out of line and many other defects which must be remedied before they can turn out satisfactory product. Nor is this condition confined to the product of shops that are new in the machine-building line; unfortunately for future reputations some of the older and regular builders have not maintained their accustomed accuracy in all cases.

In marked contrast with the feverish haste in many shops was one recently visited. Orders were piled up ahead, and the office force was rushed in every department.

The shop, however, seemed to show no trace of this. Men were busy as they always are, and work was going along as rapidly as the facilities would permit. But there was no feeling of rushing the work out. Fitting was going on as carefully as usual, and the final tests had in no wise been shortened.

Probably a few more machines might have been turned out by introducing a shop hustler under any one of a variety of names, and a few more dollars added to the bank account for the present at least. But there would also be mistakes and inaccuracies to explain away or to live down, and some are remarkably long-lived.

Inspection under the severe stress of present demand is a most difficult problem, and redoubled efforts are necessary to maintain standard accuracy. But those who meet the test and whose machines still retain their accustomed quality are sure to reap their reward in future business both at home and abroad. When a customer can say, "These machines were right in spite of rush orders," there is no question as to who gets his future business.

Maintaining a reputation for accuracy under stress of accumulated orders and refraining from boosting prices solely because of a customer's necessity are tests which must make for permanency in any line.

An Aid in Removing Prejudice

A reader and correspondent of the *American Machinist* writes that one use he makes of the editorial pages is to remove prejudice from the minds of his foremen and workmen. This unusual use shows one of the little-mentioned benefits that come to the shops from technical journalism.

We are all apt to be suspicious of the new and untried; we are too readily disposed to be prejudiced against home-made suggestions; we lean toward devices and ideas that have been tried out by someone else. Thus something is really needed to introduce us to new things—to break the ice.

The prejudice that makes such an introduction necessary is one of the things that technical journals assist in removing. Men in the shop are predisposed to look favorably upon the devices, methods, tools and ideas presented on the printed page. Thus it is not difficult to persuade them to try these things in their daily work. The fact that someone else has used the scheme establishes a precedent, and the fact that it has been described in a reputable technical journal stamps it with the badge of practicability. An old saying is, "What man has done man can do."

The other side of the shield shows the responsibility of technical editors in so selecting material for publication that the devices presented are such as will be of service. This means that the test of practical use must be applied to everything that is finally allowed to enter the editorial pages. Following this thought a little farther, we come to that oft-repeated half truth that an editor should be thanked for the material that he "kills" rather than for that which he publishes.

Efficiency in Securing Facts

Efficiency in any line begins with knowing clearly what you want done and in making this equally clear to those who are to do the work. This, in shopwork, is accomplished by means of blueprints, instruction sheets and oral orders. But when it comes to getting information, we are very apt to be anything but precise or efficient.

This office is a clearing house for inquiries of all kinds, from feather-renovating machines to tools for locomotive building. And all too many of the inquiries are vague in the extreme. Some ask us who make grinders, without an inkling as to the kind of work to be done; who makes balancing machines; what machines are best for tapping, and similar requests. In few cases are sufficient data given.

Much time can be saved to those making inquiries if all pertinent data are given when making the inquiry. The kind of work to be done and the quantity to be made are most important. Further details as to the functions of the piece to be made, the shop conditions where it is to be made and used, and particularly the accuracy required, are essential to one who wishes to answer inquiries intelligently and promptly. Do not be more secretive than absolutely necessary, as the full details might enable us to suggest a machine or method which would be better and more economical in every way.

Asking yourself if you could answer a similar inquiry from the facts given may help to show what information is necessary for efficiency on both sides.

October Exports of Metal-Working Machinery

The detailed figures in regard to the exports of metal-working machinery for the port of New York for the month of October have been delayed for two principal reasons—the perfecting of a new system of classifying these records, and the additional amount of work required to handle the enormous volume of business passing through the offices of the Custom-House. However, the figures are now available and show that the total

	July	August	September	October
Denmark	$6,189	$921	$8,989	$4,144
France	913,027	587,131	787,294	824,050
Greece	.....	1,520	57	491
Italy	47,397	74,747	52,804	50,016
Austria	.....	18,135	.....	.....
Netherlands	18,083	51,976	40,605	27,536
Norway	7,600	3,669	5,547	6,769
Portugal	.....	64	.....	.....
European Russia	554,154	644,138	601,032	483,564
Spain	7,710	35,296	37,264	41,987
Sweden	28,160	15,779	25,875	13,792
Switzerland	2,691	199,750	4,876	12,951
England	1,312,034	1,348,199	1,070,819	1,108,040
Scotland	49,837	18,579	15,570	28,470
Ireland	255	.....	.....	1,865
Finland	.....	.....	.....	120
Guatemala	.....	899	89	.....
Honduras	19	319	341	.....
Costa Rica	697	.....	.....	.....
Nicaragua	67	80	.....	.....
Panama	32	1,250	240	2,064
Mexico	174	83	6,363	146
Salvador	.....	118	.....	.....
Jamaica	.....	.....	.....	15
Cuba	28,023	12,128	6,746	6,251
Haiti	.....	.....	.....	22
Santo Domingo	696	231	488	1,190
Argentina	5,095	5,745	10,188	2,276
Brazil	5,363	328	.....	560
Colombia	173	234	165	332
Chile	848	10,502	.....	.....
Ecuador	641	.....	.....	.....
Peru	1,526	153	.....	.....
British Guiana	.....	.....	.....	127
Uruguay	164	418	1,237	78
Venezuela	63	.....	769	820
China	4,780	.....	9,145	1,203
Chosen (Korea)	1,539	.....	.....	.....
British India	6,883	3,503	817	2,091
Straits Settlements	715	.....	62	.....
Dutch East Indies	3,106	13,207	1,621	.....
Hongkong	.....	.....	600	.....
Japan	6,464	3,753	5,028	999
Russia in Asia	.....	.....	.....	9,604
Australia and Tasmania	135,898	.....	21,996	17,258
New Zealand	3,746	3,768	4,793	1,253
Philippine Islands	.....	1,782	284	38
British South Africa	6,749	3,876	6,167	3,698
Madagascar	.....	60	.....	.....
Morocco	.....	.....	355	.....
Portuguese Africa	.....	.....	786	658
Total	$3,160,598	$3,062,341	$2,729,012	$2,654,480

of these shipments has a value of $2,654,480. The total for the first four months of this fiscal year is $11,606,431. Increasing this by 10 per cent. to allow for shipments through other ports gives a probable total for the United States of $12,767,000.

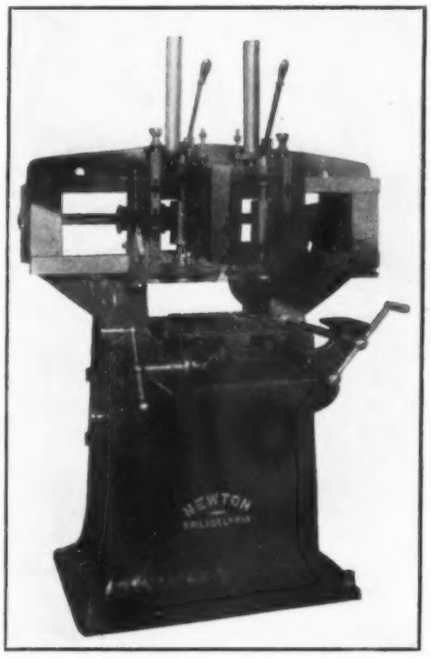
The accompanying table gives a comparison of the shipments from the port of New York month by month for July, August, September and October.

Shop Equipment News

Manufacturing Profile Miller

The illustration shows one of the profile millers recently built by the Newton Machine Tool Works, Inc., Philadelphia, Penn.

The spindles, mounted on separate slides, have hand vertical adjustment, revolve in double taper bronze boxes



PROFILE MILLER

top and bottom which are adjustable to permit running fits. Each spindle slide is poised on a spring mounted inside the covers, which act as an automatic saddle return, and a lever controls the vertical movement, the extremes of which are determined by fixed and adjustable stops on a gage.

Duplication of parts having faces to be finished at one or more elevations is facilitated by removable gage strips with independent set-ups. A latch then controls the one or several operating heights by engaging suitable notches in master gage strips. When desired, the spindle saddle may be rigidly held by a clamp.

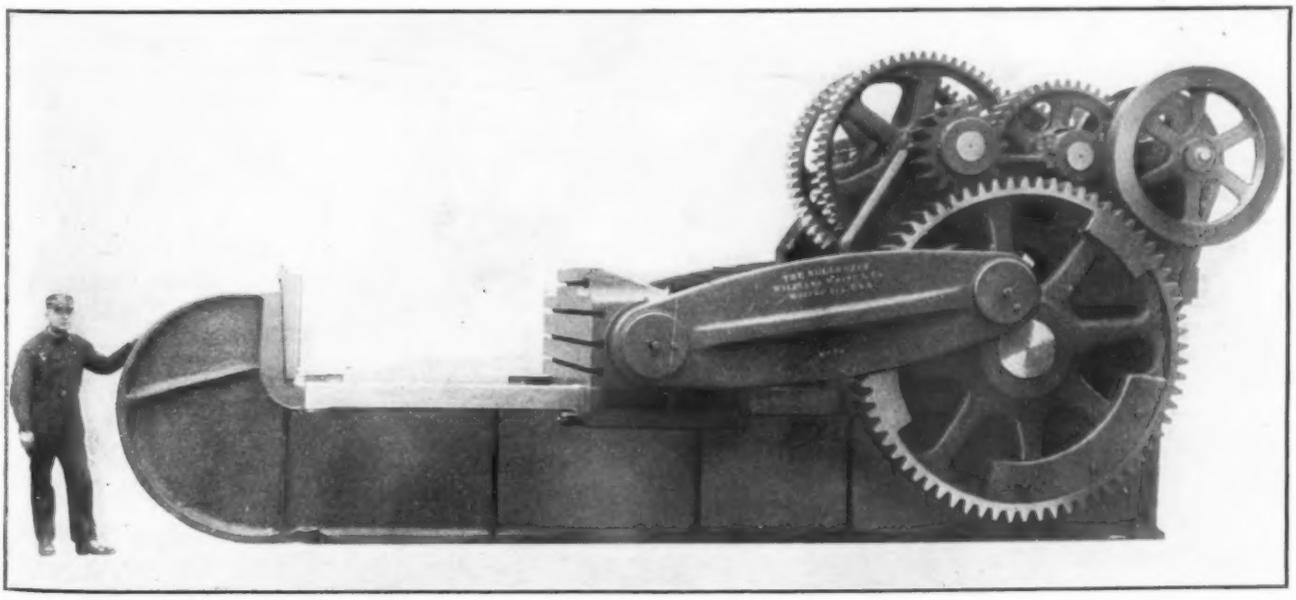
The pilot mounted on the duplex saddle is guided across the master former by a hand lever that controls the compounded spur gears engaging the adjusting rack on the bottom of the saddle. For lengthwise operations the table to which the master and work are attached is moved through compound gears controlled by a lever. Spur gears only are used throughout. Each one is made in two cylindrical parts to allow expansion of tooth by rotation of one part to take up any slight lost motion that might result from wear.

The spindles are driven by continuous belts direct from the countershaft to spindle sleeves. These belts are guided by a sliding-idle pulley. Inasmuch as this machine was designed primarily for manufacturing purposes, only two spindle speeds are provided, namely, 840 and 1,200 revolutions per minute.

Heavy Motor-Driven Bulldozer

The bulldozer illustrated, recently constructed by Williams, White & Co., Moline, Ill., is believed to be the largest of its type ever built.

The gears and pinions are all of steel with cut teeth. The main bed and side arms are of cast steel. A large steel shaft is fitted through the sliding casting, the ends of which serve as trunnions. The drive is by a 75-hp.



HEAVY MOTOR-DRIVEN BULLDOZER ESPECIALLY ADAPTED FOR SHELL FORGING

motor, direct-connected through cut gearing, the motor resting on a bracket bolted to the housings.

The machine has forward and reverse gearing, both movements being controlled by friction clutches. The crosshead and ways are provided with T-slots. The end lugs are provided with taper gibs instead of the usual adjusting screws for adjusting the dies.

Some idea of the great size of this machine can be gained from the facts that it is 26 ft. long by 12 ft. wide and exerts a pressure of 500 tons' distributed load.

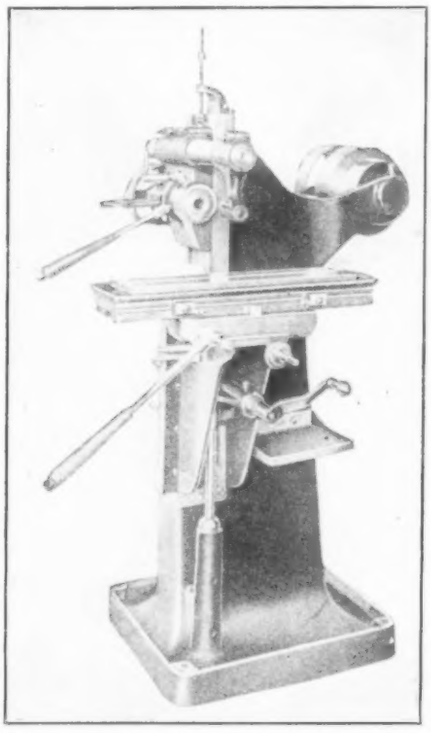
This type of machine is being used successfully for forging shrapnel and high-explosive shells.

High-Speed Hand Miller

In the hand miller shown, taper roller bearings are provided for the spindle, front and rear bearings, as well as for the back-shaft bearings. These bearings are calculated to minimize thrust friction and to take care of the crushing strain.

The machine is capable of running at a speed of 1,200 to 1,500 r.p.m., which permits the use of end mills, or fish-tail cutters, from $\frac{3}{16}$ in. up. It is especially adapted to spline milling, because of the high speed.

The machine can be equipped with a V-block fixture, an oil pan and a pump. It is capable of carrying two



HIGH-SPEED HAND MILLER

3-in. straddle mills at a normal cutting speed. The clamping levers for the head saddle are conveniently located for the operator, on the front of the saddle. All feed screws are milled.

The head has 5-in. vertical travel by lever. The table overall measures 8x26 in., with a working surface of 5x17 in. The maximum distance from the spindle to the table is 14 in. The table feed by lever is 4 in. By the use of a crank handle furnished with the machine the table has 17-in. travel. Positive stops are located on the side of the table. The driving pulley on the spindle is 6x3⅛ in. and is driven by a 10x3⅛-in. pulley on the back shaft. Where 1,200 to 1,500 r.p.m. are required, a special pulley is furnished with the machine for the spindle drive.

The bearings are self-oiling both in the shaft and in the machine proper. The machine weighs about 1,080 lb. and is manufactured by the Kent-Owens Machine Co., Toledo, Ohio. Its marketing is in the hands of the P. H. Biggs Machinery Co., Cleveland, Ohio.

Flexible Curve Rule

The flexibility of the curve rule illustrated is secured by the use of black xylonite which is notched from opposite edges.

On one edge is a ruling strip of black xylonite, and on the other a metal wire for retaining the rule in any curve

FLEXIBLE CURVE RULE

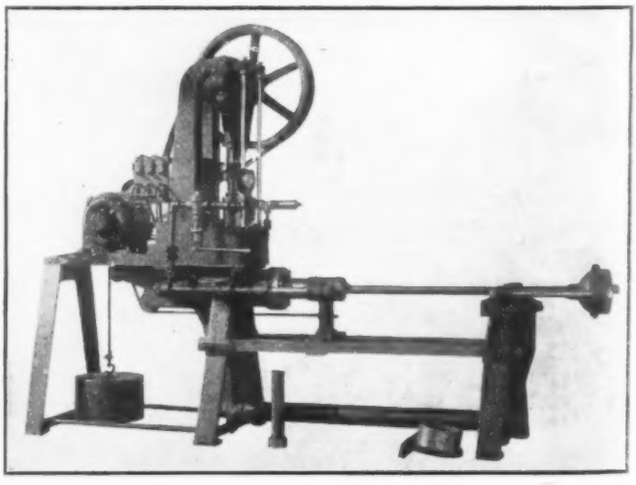
into which it may be bent. One extremity ends in a tangent.

The rule is a recent product of the Keuffel & Esser Co., Hoboken, N. J., and is made in a number of sizes.

Horizontal Forcing Press

The horizontal forcing press shown has a high-speed stroke and quick return to the counterweighted ram. It is a recent addition to the line made by the Metalwood Manufacturing Co., Detroit, Mich., and is furnished belted, direct-connected motor-driven, or driven from an accumulator or with an air intensifier, either single or double end.

The pump is of the duplex type, with body of hydraulic bronze. The movement of the lever controls the in and



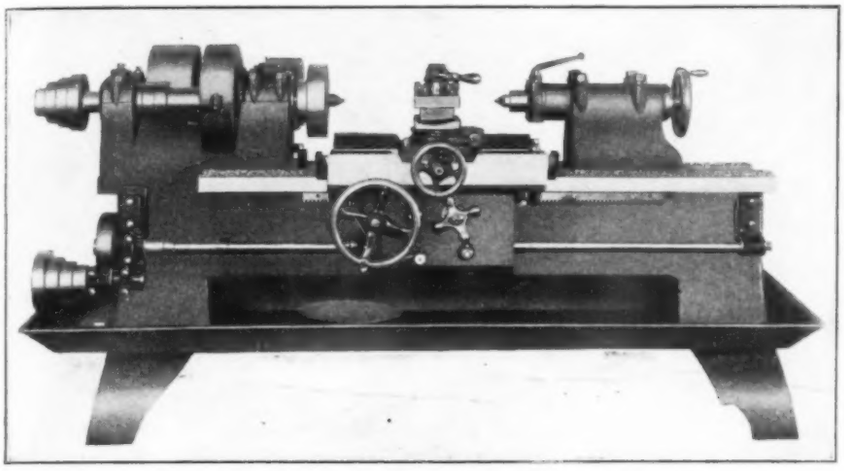
HORIZONTAL FORCING PRESS

out stroke while the pump is running continuously. The press has a 30-ton-on-ram capacity, 18-in. stroke and is provided with adjustable stops. Its overall length is 8 ft. 8 in., width 33 in. and weight 4,900 lb.

Heavy Manufacturing Lathe

The illustration shows a 20-in. heavy-duty manufacturing lathe designed especially for turning shells up to 9 in. in diameter.

Most of its features will be apparent from the illustration. It will be observed that the machine is of the single-pulley type and has a two-speed countershaft, in



HEAVY 20-IN. MANUFACTURING LATHE

connection with slip gears providing the speed changes. The spindle is of carbon steel, ground to size and bored from the solid.

All headstock journals are provided with well-lubricated renewable bronze bearings. Bronze washers take the end thrust, and adjustment is provided to take up wear.

The rear bearing of the carriage is flat, and the front V has an oil trough around it to prevent the lubricant from running down over the apron. The carriage is gibbed to the bed at the front and rear on the outside, and is also gibbed to the inside of the bed underneath the carriage bridge. The apron is of the double-plate type.

The knob for engaging the friction is made in the shape of a pilot wheel 6 in. in diameter, which seats the friction with a minimum of effort. A four-step feed cone, carrying a 1½-in. belt, is provided. A simple automatic length stop consists of a jaw clutch on the headstock end of the feed rod, a mating half clutch on the outside of the gear mounted on the feed rod, a fully inclosed spiral spring for reëngaging the feed automatically, and an adjustable collar mounted on the feed rod.

Some of the main dimensions follow: Swing over shears, 20 in.; swing over carriage, 10 in.; takes between centers, 7-ft. 6-in. bed (tailstock flush), 31½ in.; front spindle bearing, 4x7 in.; rear spindle bearing, 3x5 in.; hole through spindle, 1⅜ in.; diameter of spindle nose, 3½ in.; width of belt, 6 in.; width of carriage bridge, 8½ in.; gear ratios, maximum 8.5 to 1, minimum 2.85 to 1. The machine is a recent product of the Shook & Fletcher Supply Co., Birmingham, Ala.

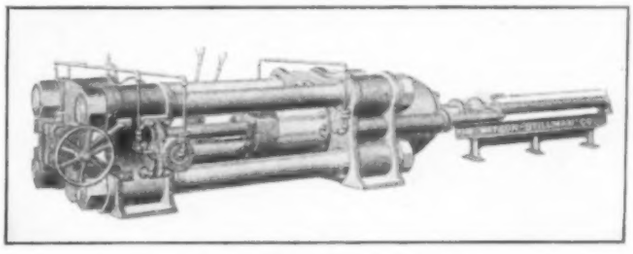
Heavy Extrusion Press

The machine illustrated is one of the line of the Watson-Stillman Co., New York, N. Y., designed to extrude copper, brass, aluminum, alloys or any nonferrous metal. It has a capacity of approximately 850 cu.in. of metal per stroke of ram.

It will be seen that the press consists essentially of a main cylinder and plunger, a die holder, or platen, and a billet container.

The billet container is preheated and then attached to the platen by male and female connections, so that the metal cannot escape except through the dies. A hot slug, or billet, is then transferred to the slug carrier, which is in line with the billet container. The billet is pushed out of the slug carrier into the billet container by a rod running through the main ram and operated by an air cylinder, shown at the back end of the press. This rod is then withdrawn, and the plunger, which is made of a special steel to resist the heat and take the full 2,000 tons pressure exerted on the ram, is dropped in front and becomes a part of the ram.

Pressure is applied to the main ram, which forces the plunger into the billet container, thus forcing the metal out of the container through the dies and on to a hot bed not shown. The dies are then cleared, the plunger is pulled back by means of pull-back cylinders, shown at each side of the main cylinder, and is ready for a new billet. The movements of the rams are governed by a set of specially designed operating valves



HEAVY EXTRUSION PRESS

which are controlled by pilot valves at the side of the press.

The press has a capacity of 2,000 tons' pressure on the plunger and works at 5,000 lb. operating pressure from either accumulator or direct pump line.

The overall dimensions of the press, without the hot bed, are 30 ft. in length, 12 ft. in width and 6 ft. in height; the length of the hot bed and runway is 40 ft., making the total length of the assembled machine 70 ft.

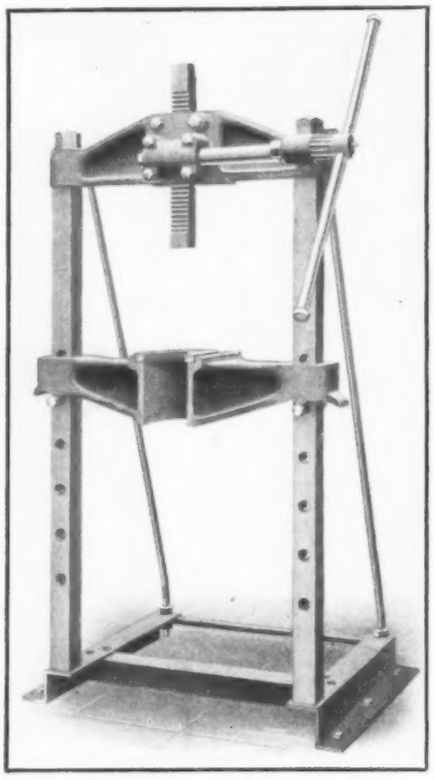
Arbor Press of Wide Range

It will be observed that the table of the arbor press shown may be readily raised or lowered, by which feature the range of the press is considerably increased. The sliding V-block on the table is instantly adjustable to accommodate different sizes of arbors.

The rack and pinion method is used for operating the ram, on which a leverage of 100 to 1 is brought to bear. The ram is of square steel and the rack of 8 pitch. The pinion is integral with the shaft, which is made of chrome-nickel steel.

The top frame and table are heavy castings to secure the necessary rigidity and strength, while the other sections are made of steel to obtain lightness.

The press has 10 tons' capacity. The maximum distance under the ram is 40 in.; capacity between standards, 21 in.; travel of ram, 12 in. The press weighs 375



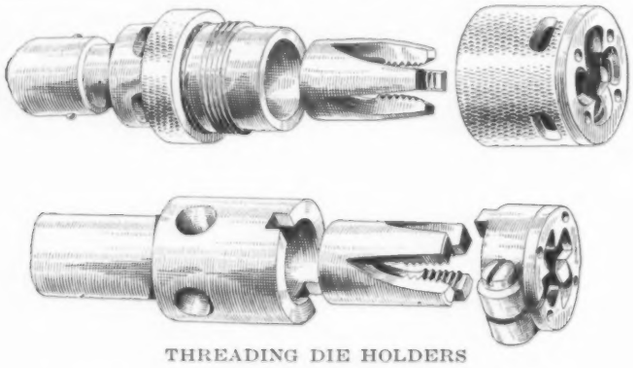
ARBOR PRESS

lb. It is a recent product of the United Engine and Manufacturing Co., Hanover, Penn.

Threading Die Holders

In the design of the spring, or prong, die holders shown, the main purpose was to furnish support near the outer ends of the prongs, where the work is being done.

The illustrations show how the support is provided by placing dogs, or stops, on the adjustable rings, which are locked firmly to the holders. In the one form, it will



THREADING DIE HOLDERS

be observed that the collar threads back on the shank of the holder, the die having a taper fit through the collar. In the other form an adjustable dog fits over the prongs of the die and is locked to the shank by projections fitting into corresponding recesses.

Both forms of holders are recent products of the J. M. Carpenter Tap and Die Co., Pawtucket, R. I.

Portable Electrical Measuring Instruments

The various portable electrical instruments shown are late additions to the lines developed by the Weston Electrical Instrument Co., Newark, N. J.

In Fig. 1 is shown a polyphase wattmeter. This form of instrument really consists of two single-phase wattmeters, electrically independent but having their movable coils mounted on a common shaft so that they rotate together. Each coil, however, moves in its own system of

FIG. 1. WATTMETER

FIG. 2. AMMETER

field coils. The weight is about 17½ lb. and the overall dimensions 9½x10½x8$\frac{1}{16}$ in.

The electrodynamometer ammeter, shown in Fig. 2, may be used with equal accuracy on either direct-current circuits or alternating-current circuits of any frequency up to 133 cycles per second and any wave form. This form will be found particularly useful as a transfer instrument from direct to alternating current and for checking electromagnetic (movable iron) or induction-type instruments, or for all measurements of current

FIG. 3. WATTMETER

FIG. 4. VOLTMETER

where very high accuracy is desired. It weighs about 11 lb., and its dimensions are 8x10¼x5¾ in.

In Fig. 3 is shown a single-phase wattmeter adapted to measurements on alternating or direct-current circuits. It can be used on circuits of any commercial frequency, even as high as 500 cycles per second, with very slight error due to phase displacement. Double ranges are provided for both current and voltage circuits. All current ranges can be used for 100 per cent. overload indefinitely without introducing error.

The last-shown instrument is a voltmeter which may be used with equal accuracy on either alternating or direct-current circuits. Its movable system has an extremely low moment of inertia and is effectively damped.

Indications are independent of room temperature, the heating effect of the current passing through the windings, and the instruments are shielded from external magnetic influences.

All of the instruments shown are carried in polished mahogany boxes provided with carrying handles, locks, and covers equipped with slip hinges. The various models are made in a variety of sizes.

NEW PUBLICATIONS

THE PURCHASING AGENT. Vol. 1, No. 1. Published by the Purchasing Agent Publishing Co., Springfield, Mass. Price, $2 per year.

This is a new monthly devoted to the interests of purchasing agents, presumably in all lines of business, although the metal industries figure largely in the first issue. The periodical contains 48 pages of interesting matter. Why the nondescript size of 7⅞x10½ in. should be adopted is something of a mystery.

THE SLIDE RULE—By Charles N. Pickworth. One hundred and twenty-two pages, 5x7 in.; 37 illustrations; cloth bound. Price, $1. D. Van Nostrand Co., New York.

This is the thirteenth edition of a well-known book on the use of the slide rule. It is a revision of preceding editions, with an extension of the text to include descriptions of various new slide rules and calculators. A note on the extraction of the fifth root has also been added, and two pages covering the gage points and signs on slide rules.

THE MOTOR CAR. By Duncan McMillan, A. M. I. M. E. 157 pages; 5x7¼ in.; cloth binding. Published by Longmans, Green & Co., New York. Price 90c. net.

This is an addition to the Technical Handicraft Series published by the Longmans company and deals with the automobile as manufactured in Great Britain. It illustrates automobile design in more or less detail, paying considerable attention to carburetors, clutches, magnetos, transmission and rear-end construction. It shows the single-plate clutch used on some of the British cars, as well as several varieties of both multiple-disk and cone clutches. It will be found of more than ordinary interest by any engineer who has to do with the building of automobiles in this or other countries.

PRACTICAL SHOP MECHANICS AND MATHEMATICS—By Joseph M. Jameson. One hundred and thirty pages, 5x7 in.; 81 illustrations; indexed. Price, $1. John Wiley & Sons, Inc., New York.

REVIEWED BY DEXTER S. KIMBALL*

The contents of this book is based on notes used by the author for nine years in evening schools and in technical and trade schools. It is intended to give students in the trades a simple treatment of elementary shop mechanics.

The contents of the volume are as follows: Materials, Measures and Weights, Measuring Instruments, Pulleys and Belting, Tooth Gearing, Force and Its Relation to Work, Forces, Stresses and Strain, Angle Measurements, and an Appendix containing tables of circumferences and areas of circles, squares, square roots, etc. The chapter on belts deals with simple shop problems of this character and the chapter on toothed gears deals with velocity ratios as applied to screw cutting and not to the question of strength of teeth. Chapter 8 is devoted to elementary trigonometric relations.

It will be seen therefore that the book is really an elementary treatise on mechanics and mechanics of materials. A knowledge of elementary mathematics is required, the mathematics included in the text being applied mathematics entirely. The discussion and examples in the text relate to common shop processes and problems. It would seem therefore that the term "practical" in the title of the book is unnecessary, since all shop mechanics and mathematics are necessarily very practical.

The book is clearly written and attractively printed and any mechanic who understands elementary mathematics will find it useful and within his capacity for home study.

*Professor of machine design and construction, Sibley College, Cornell University.

EXPERIENCES IN EFFICIENCY—By Benjamin A. Franklin. One hundred and seventy-eight pages, 5x8 in.; cloth bound. Price, $1. Engineering Magazine Co., New York.

REVIEWED BY DEXTER S. KIMBALL*

A considerable portion of the subject matter of this book appeared originally in the "Engineering Magazine." As now published, however, it has been revised and added to, and the entire matter rearranged in a logical order. Though each chapter treats of an entirely different topic, the sequence of topics is that in which they would naturally engage a manager's attention. Each chapter is intended to show how the problems discussed therein were solved in specific cases in actual practice, the illustrations being drawn from the experience of the author. The discussions are all of a general character; that is, they tell briefly how the problem in hand was met and solved, without entering into the details of the methods employed.

Chapter 1, entitled "Profiting by Workmen's Tendencies," discusses the necessity of obtaining the workman's interest. Chapter 2 is headed "Securing Quality of Output." Chapter 3, "Quality Piece Work," discusses the necessity of sometimes putting a premium on quality as well as on quantity. Chapter 4, "Gang Piece Work," shows, as its name implies, how good results often may be obtained by putting an entire gang on piece work, the net earnings being divided among the men on a graduated scale. Chapter 5 on "The Problems of Clerical Work," one of the best chapters in the book, calls attention to the need for striving after efficiency in the office as well as in the shop. Chapter 6 deals with the benefits and problems of putting the entire force on a bonus plan of some kind. Chapter 7 discusses the benefits that sometimes can be obtained by a simple reorganization of the methods employed, particularly when such reorganization leads to a more systematic planning of the work. Chapter 8, entitled "Reducing Factory Expenses," is a plea for better expense analysis and an intelligent use of such analysis. Chapter 9 describes an experience in building up a cost system and the benefits that came out of it. Chapter 10, "Efficiency Will," is a discussion of the conditions that must exist in a plant in order that efficiency methods may be successful.

The book is full of good suggestions and, while several of the methods advocated are in use in a number of establishments, there are many executives who can read the book with profit. The examples cited are for the most part small concerns, but the methods recommended are well-established and are applicable to a business of any size.

The author's enthusiasm for his subject has, I believe, obscured his vision on some points. On page 68 he states that there are three main methods for increasing the efficiency of labor—the use of machinery (transfer of skill so-called), the building of an executive organization to assume to the maximum all the functions of preparation up to the final operation, and the rewarding of labor in some fixed proportion to its attainment of results.

Now, as a matter of fact, the great principles used by man in increasing his productive capacity are transfer of skill and divison of labor. While preplanning involves division of labor, division of labor itself is something much wider and may or may not involve preplanning such as Mr. Franklin has in mind. Division of labor is made more effective when the work of the men concerned is properly coördinated; and preplanning is synonymous with coördination. It should be noted that these principles are the basic ones and apply whether the workman is rewarded in proportion to his effort. We, in this age, advocate such reward, but in time past the extra exertion was obtained by other means; in fact, it is even now sometimes obtained through fear instead of through financial stimulation.

Mr. Franklin's statement in connection with the discussion on cost finding that "the complete facts of the business can be shown in any way desired" will be doubted by some who have had experience with cost-finding in large works where many lines of goods are made. It may be that in small factories, manufacturing a few lines of goods, fairly accurate statements may be made; but in large and complex establishments exact costs are difficult, if not impossible, to obtain, though approximations good enough for all purposes can be found.

Little is said in the book about the gains that often can be secured by changes in equipment—whether these changes be of the character of rearrangements, changes or additions. Yet sometimes efficiency can be effected in this manner much more easily than by changes in the administrative methods. The book, however, is devoted mainly to changes of the latter type, and for those interested in such problems it will repay reading.

*Professor of machine design and construction, Sibley College, Cornell University.

Prices--Materials and Supplies

PIG IRON—Quotations were current as follows at the points and dates indicated:

	Dec. 23, 1915	Nov. 26, 1915	Dec. 24, 1914
No. 2 Southern Foundry, Birmingham	$14.50	$13.50	$10.00
No. 2X Northern Foundry, New York	19.00	17.75	14.20
No. 2 Northern Foundry, Chicago	18.00	17.50	13.00
Bessemer, Pittsburgh	19.45	17.95	14.70
Basic, Pittsburgh	18.95	16.95	13.45

METALS—Below are the present quotations with a comparison of a month and year ago:

MISCELLANEOUS METALS—NEW YORK

	Dec. 23, 1915	Nov. 26, 1915	Dec. 24, 1914
	Cents per pound		
Copper, electrolytic (carload lots)	21.00	20.00	13.50
Tin	38.75	*40.00	34.25
Lead	5.40	5.25	3.80
Spelter	18.00	18.50	5.85
Copper sheets, base	26.00	25.00	18.50
Copper wire (carload lots)	29.25	28.25	14.25
Brass rods, base	29.25	27.25	13.00
Brass pipe, base	34.00	32.00	15.50
Brass sheets	29.25	27.25	13.25
Solder ¼ and ½ (case lots)	26.25	23.50	19.88

*This quotation is nominal.

MONEL METAL—The following prices hold:

Size, In.	Mill Lengths 8 Ft. and Over: 10,000 Lb. of a Size and Over	6,000 Lb. of a Size and Over	2,000 Lb. of a Size and Over	500 Lb. of a Size and Over	Less than 500 Lb. of a Size and Over
Rounds—Squares	Cents per Pound				
1/16 — 3/32	31.50	32.00	32.50	33.00	36.00
1/8 — 7/32	31.25	31.75	32.25	32.75	35.75
1/4 to 1 1/2	31.00	31.50	32.00	32.50	35.50
1 13/16 to 2 1/4	31.75	32.25	32.75	33.25	36.25
Rounds					
3 to 3 7/16	32.50	33.00	33.50	36.00	37.00
Squares					
3	32.50	33.00	33.50	36.00	37.00
Rounds					
3 1/2 to 3 11/16	32.25	32.75	33.25	35.75	36.75
Squares					
3 7/16 to 3 11/16	32.25	32.75	33.25	35.75	36.75
Rounds—Squares					
4 to 4 1/16	33.00	33.50	36.00	36.50	37.50
5 to 6 1/16	36.00	36.50	37.00	34.50	38.50
7	36.50	37.00	37.50	38.00	39.00
Flats	32.50	33.00	33.50	36.00	37.00

Flats not rolled wider than 6 in. or less than ¼ in. thick.
Hexagon Bars two cents (2c) per pound over corresponding size of round rods

For cutting to any specified length not shorter than 1 ft. add 1c. per lb.

The scrap allowance is 18c. per lb. delivered at works.

STANDARD PIPE—On carload lots f.o.b. Pittsburgh the following discounts hold:

	Black	Galvanized
¾ to 2-in. steel, butt welded	78%	63½%
2½ to 6-in. steel lap welded	77%	62½%
7 to 12-in. steel lap welded	75%	58½%

At this rate prices are as follows:

Diameter	Cents: Black	Cents: Galvanized	Diameter	Cents: Black	Cents: Galvanized
¾-in.	2.53	4.19	5-in.	34.04	55.50
1-in.	3.74	6.30	6-in.	44.16	72.00
1¼-in.	5.06	8.39	7-in.	59.50	98.77
1½-in.	6.05	10.02	8-in.	62.50	$1.03
2-in.	8.15	12.55	9-in.	86.25	1.43
2½-in.	13.45	21.92	10-in.	$1.03	1.70
3-in.	17.59	28.68	11-in.	1.16	1.92
4-in.	25.07	40.87	12-in.	1.27	2.10

SAL SODA sells at 1c. per lb in bbl. lots in New York. The price in Philadelphia is 75c. per 100 lb.

ROLL SULPHUR in 360-lb. bbl. sells in New York at $2.15 per 100 lb.

ZINC SHEETS—The following prices prevail:

Quantity	Cents per Lb.
Carload lots, f.o.b. mill	22.00
In casks, New York	22.50
Broken lots, New York	23.00

MACHINE BOLTS—From New York warehouse, on sizes from ⅜ in. by 4 in. and smaller 70% off list is discounted; for larger and longer sizes 60% is allowed. These quotations are for bolts having square heads and square nuts. At this rate prices per 100 are as follows:

Length	Diameter: ¼	⅜	½	¾	⅞	1 In.
1½ in.	$0.51	$0.72	$2.08	$3.08	$4.20	$6.04
2 in.	.53	.77	2.23	3.30	4.48	6.40
2½ in.	.56	.82	2.38	3.52	4.76	6.76
3 in.	.58	.86	2.53	3.74	5.04	7.12
3½ in.	.61	.91	2.69	3.96	5.32	7.48

CARRIAGE BOLTS—On ⅜ by 6 in. and smaller 65 and 10% off list is allowed; for larger and longer sizes 60% off list is charged . At this rate the price per 100 is as follows:

Length	Diameter: ¼	5/16	⅜	7/16	½	⅝	¾
1½ in.	$0.32	$0.44	$0.60	$0.88	....	....	....
2 in.	.35	.48	.65	.96	....	....	....
2½ in.	.38	.52	.70	1.04	$1.30	$2.30	$3.10
3 in.	.41	.55	.75	1.12	1.41	2.45	3.60
3½ in.	.44	.59	.80	1.20	1.52	2.60	3.80

STEEL SHEETS FROM JOBBERS' WAREHOUSE, NEW YORK

	Dec. 23, 1915	Nov. 26, 1915	Dec. 24, 1914
	Cents per pound		
No. 28 Black	3.15	3.15	2.60
No. 26 Black	3.05	3.05	2.50
Nos. 22 and 24 Black	3.00	3.00	2.45
Nos. 18 and 20 Black	2.95	2.95	2.40
No. 16 Black	2.90	2.90	2.35
No. 14 Black	2.80	2.80	2.25
No. 12 Black	2.70	2.70	2.20
No. 28 Galvanized	5.25	5.00	3.50
No. 26 Galvanized	4.95	4.70	3.20
No. 24 Galvanized	4.80	4.55	3.05

RIVETS—Steel tank rivets ⅞ and smaller sell at 70% off list. On copper rivets 40 and 5% off list is asked. On burs 20% off list is quoted.

STEEL SHAPES FROM JOBBERS' WAREHOUSE, NEW YORK

	Dec. 23, 1915	Nov. 26, 1915	Dec. 24, 1914
	Cents per pound		
Steel angles base	2.40	2.40	1.85
Steel T's base	2.45	2.45	1.90
Machinery steel (bessemer)	2.40	2.35	1.80

The above prices are for angles 3 in. by ¼ in. and larger and tees 3 in. and larger.

SWEDISH (NORWAY) IRON—This material sells at $4.25 per 100 lb. f.o.b. New York.

COKE—Below are the prices per net ton at ovens, Connellsville, and cover the past four weeks:

	Dec. 4 1915	Dec. 11 1915	Dec. 18 1915	Dec. 25 1915
Prompt furnace	$2.15@2.25	$2.15@2.25	$2.50@3.00	$3.00@3.50
Prompt foundry	2.90@3.25	2.90@3.25	3.25@3.75	3.50@4.00

COTTON WASTE—White cotton waste at New York sells at 7½ to 9½c. per lb. ,and colored mixed at 5½ to 8c.

OILS—Prime winter lard oil sells at 92@96c. per gal. in 5-bbl. lots; cottonseed crude, f.o.b. mill, 55c.; and linseed, raw, in carload lots, at 61c.

OLD METALS—The following are the dealers' purchasing prices in New York:

Copper	Cents per Lb.	Brass	Cents per Lb.
Heavy and crucible	16.75	Heavy	11.25
Heavy and wire	16.25	Light	9.25
Light and bottoms	14.25	No. 1 yellow rod turnings	11.50
Lead		No. 1 red turnings	11.00
Heavy	4.50		
Tea	4.25	Zinc	11.00

SEAMLESS DRAWN TUBING—The base price is 33c. for brass and 33c. for copper. For immediate stock shipment 2c is added, which gives the following quotations in cents per lb.

Diam., In.	Brass	Copper	Diam., In.	Brass	Copper
¾ to 3	35.00	35.00	5	41.50	41.00
3½	36.50	36.00	6	42.50	42.00
4	37.50	37.00	7	44.50	44.00
4½	39.50	39.00	8	46.60	46.10

COPPER BARS—The base price is 27½c. per lb.

BABBITT METAL—Best grades are selling from 55 to 60c. per lb. Ordinary commercial grades command 25 to 30c. per lb.

WELDING MATERIAL (SWEDISH)—Prices are as follows:

Welding Wire	Cents per Lb.
3/32, 1/8, 5/32, 3/16, 7/32, 1/4	8.50
No. 8, 5/16 and No. 10	9.25
3/8	10.00
No. 12	11.00
7/16, No. 14 and 1/2	12.00
No. 18	14.00
No. 20	16.00

Special Welding Steel	
1/8	33.00
5/32	30.00
3/16	28.00

Cast-Iron Welding Rods	Cents per Lb.
1/4 by 19 in. long	22.00
5/16 by 12 in. long	26.00
5/16 by 19 in. long	20.00
1/2 by 21 in. long	20.00

Vanadium Wire in Coils or Sticks	
1/16	15.50
5/64	15.00
1/8	14.00
5/32	12.00
3/16 and larger	11.00

The above prices are subject to change according to quantity and shipment desired.

ANTIMONY—For spot delivery on Chinese and Japanese brands, duty paid, 39.5c. per lb. is asked.

COLD DRAWN STEEL SHAFTING—To consumers requiring fair-sized lots the price at 30% off list.

NAILS—Wire nails f.o.b. Pittsburgh sell at $2.10; galvanized 1 in. and longer, $4.10, and shorter, $4.60. These prices are to regular customers and delivery is made at the mill's convenience.

WROUGHT WASHERS—From New York warehouse the present quotation is $5 from list price. At this rate the following prices hold:

Diameter, In.	Price per 100 Lb.	Diameter, In.	Price per 100 Lb.
5/16	$9.00	1 1/2	$4.30
3/4	7.20	1 3/4	4.20
7/8	6.40	2	4.10
1	5.50	2 1/4, 2 1/2, 2 3/4	4.00
1 1/4	4.80	3, 3 1/4, 3 1/2	4.20
1 3/8	4.40	3 3/4, 4, 4 1/4, 4 1/2	4.50

NUTS—On hot pressed square nuts $4 off list is allowed and on hexagon $4.20. At this rate, the following prices hold:

Hot Pressed Square			Hot Pressed Hexagon		
Short Diam.	Per 100 Lb. Blank	Per 100 Lb. Tapped	Short Diam.	Per 100 Lb. Blank	Per 100 Lb. Tapped
1/2		$11.00	1/2		$16.70
5/8	$7.00	8.50	5/8		10.30
11/16	5.00	5.90	3/4	$5.40	6.40
3/4	4.00	4.70	7/8	4.20	4.80
1 1/4	3.50	3.90	1 1/8, 1 1/4, 1 1/8, 2	4.10	4.70
1 1/8, 1 1/8, 1 1/8, 2	3.40	3.80	2 1/4	4.20	4.90
2 1/4	3.50	4.00	2 3/8	4.50	6.30
2 3/8	3.80	4.40			

Semifinished nuts sell at 75% off list.

New and Enlarged Shops

If you are in need of machinery or supplies, the first thing to do is to consult the Buying Section. If you cannot find just what you want, send us particulars, and we will be glad to publish it free of cost, thus putting you in touch with reliable manufacturers.

METAL WORKING

NEW ENGLAND STATES

Work will soon be started on the construction of a two-story, 45x125-ft. garage at Boston, Mass., for E. A. Patch. Estimated cost, $40,000.

The Clinton Wire Cloth Co. awarded the contract for the construction of a testing plant on Parker St., Worcester, Mass.

Plans have been prepared for the construction of a one-story machine shop addition to the plant of the Wyman & Gordon Co., Worcester, Mass.

Bids have been received for the construction of a five-story, 50x260-ft. machine shop at Bridgeport, Conn., for the Bullard Machine Tool Co. Noted Nov. 18.

Bids are being received by Isaac Allen, Jr., Arch., for a one-story, 54x145-ft., with L 27x61-ft., garage and service station at Hartford, Conn., for George D. Knox. Estimated cost, $15,000.

Plans have been prepared for two-story, 32x97-ft. garage at Hartford, Conn., for Tuttle & Hurtes. Estimated cost, $15,000.

Bids are being received for the construction of a 30x105-ft. addition to the plant of Landers, Frary & Clark, manufacturer of cutlery and hardware, New Britain, Conn.

Work has been started on the construction of an addition to the plant of the Yale & Towne Co., manufacturer of locks and tools, Stamford, Conn. Noted Dec. 2.

The contract has been awarded for the construction of a plant on Washington St., Waterbury, Conn., for the American Brass Co. Estimated cost, $17,000.

Plans are being prepared for the construction of a five-story, 72x200-ft. factory at Waterbury, Conn., for the Waterbury Clock Co. E. E. Benedict, 51 Leavenworth St., Arch.

MIDDLE ATLANTIC STATES

The contract has been awarded for the construction of a garage at Buffalo, N. Y., for Charles M. Peabody, 588 Main St. Estimated cost, $20,000.

The Trumbridge Realty Co., Hotel St. George, New York, N. Y. (Borough of Brooklyn), has awarded the contract for the construction of a garage. Estimated cost, $10,000.

The General Electric Co., Schenectady, N. Y., is building a one-story, 60x208-ft. addition to its plant. Estimated cost, $25,00. Noted Oct. 14.

A company will be formed by Elias C. Vail, J. Wilson Poucher and Grant E. Smith to be known as the Pouvailsmith Corporation with $2,500,000 capital stock. The new company will take over the plant of the Warm Hand Steering Corporation, Poughkeepsie, N. Y., and the condensite department of the Essex Rubber Co., Trenton, N. J., and will build two one-story buildings at Poughkeepsie, N. Y., for the manufacture of all kinds of condensite products for automobiles.

The contract has been awarded for the construction of a factory for the American Gas Accumulator Co., Elizabeth, N. J. Noted Nov. 18.

Ring, Cleaves & Graham will build a machine shop at Elizabeth, N. J.

Bids will soon be received for a two-story machine shop at Elizabethport, N. J. (Elizabeth post office), for S. L. Moore Son Corporation. Estimated cost, $160,000.

The contract has been awarded for the construction of a four-story, 100x150-ft. factory for the Joseph Dixon Crucible Co., 349-59 Monmouth St., Jersey City, N. J. Estimated cost, $50,000.

The Splitdorf Electrical Co., Newark, N. J., is building a six-story, 50x300-ft. addition to its plant. Noted Nov. 25.

Bids are being received by Fred Diehl, 16th St. and Hudson Ave., West New York, N. J., for a two-story, 50x100-ft. garage.

The Midvale Steel and Ordnance Co., Coatesville, Penn., will enlarge its plant. Estimated cost, $6,000,000.

The shops of the Weimer Machine Co., Lebanon, Penn., recently destroyed by fire with a loss of $100,000, will be rebuilt. Noted Nov. 25.

The Belmont Iron Works plans to build a hammer shop at Milnor and Bleight St., Philadelphia, Penn. Estimated cost, $10,000.

The contract has been awarded for the construction of a two-story, 50x100-ft. foundry at Frankford Ave. and Vandyke St., Philadelphia, Penn., for the Schneider-Bowman Co. Noted Dec. 9.

The contract has been awarded for the construction of a machine shop at 23rd and Ontario St., Philadelphia, Penn., for the Tioga Machine Co. Noted Nov. 11.

Plans are being prepared for a two-story, 50x100-ft. commercial garage at Oakmont, Penn., for Earl Clements. Estimated cost, $15,000. D. A. Crone, Oliver Bldg., Pittsburgh, Penn., is Arch.

We have been informed that the Pittsburgh Knife and Forge Co., Belmont and Chateau St., Pittsburgh, Penn., is rebuilding its plant which was recently damaged by fire. Noted Dec. 16.

George W. Eisenhauer, 1728 North Charles St., Baltimore, Md., will soon award the contract for a two-story garage. Estimated cost, $20,000.

The contract has been awarded for the construction of a garage for Henry Steeger, 304 West 88th St., New York, N. Y. (Borough of Manhattan), to be leased by Blue Spricket Garage, 6 East 31st St. Estimated cost, $35,000.

The contract has been awarded for a garage for R. E. Trimble and F. M. Clark, Washington, D. C. Estimated cost, $10,000.

J. H. Wurdemann, Washington, D. C., has awarded the contract for a one-story garage. Estimated cost, $15,000.

SOUTHERN STATES

Bids are being received by the Kanawha Mfg. Co., manufacturer of mine cars, boilers, etc., Charleston, W. Va., for two factory buildings.

N. S. Parks and W. W. Johnson will build a two-story brick garage at Philippi, W. Va.

The Wheeling Steel and Iron Co., Wheeling, W. Va., plans to build a combination sheet and bar mill. Estimated cost, $200,000. I. M. Scott, Pres.

According to press reports the Gulf States Steel Co., Birmingham, Ala., contemplates the construction of a by-products plant at Gadsden, Ala.

The Cleveland Buick Co., Cleveland, Tenn., is in the market for repair tools for a garage. George R. Berger is interested.

The Southern Ry., Washington, D. C., will build a steel car-repair shop at Cosfer, Tenn.

Work will be started next spring on the construction of an openhearth steel plant at Ashland, Ky. Estimated cost, $850,000. Ashland Coal and Iron Ry., John Russell and W. B. Seaton are interested.

The Chesapeake & Ohio Ry., Richmond, Va., is building a car repair shop at Lexington, Ky.

MIDDLE WEST

Work will soon be started on the construction of a four-story, 256x260-ft. factory at Cincinnati, Ohio, for the American Tool Works Co., Cincinnati. Estimated cost, $250,000. Noted Dec. 9.

The John Steptoe Shaper Co., manufacturer of machinists tools, will build a two-story, 65x85-ft. addition to its plant on Colerain Ave., Cincinnati, Ohio.

Bids will soon be received for the construction of a two-story, 50x100-ft. garage for T. J. McNamee, Market St., St. Clairsville, Ohio.

The contract has been awarded for the construction of a factory on Ivanhoe Rd., Cleveland, Ohio, for the Frantz Premier Co., manufacturer of sheet-metal works. Estimated cost, $10,000.

The contract has been awarded for the construction of a factory at 2108 Superior Viaduct, Cleveland, Ohio, for the Strangward Realty Co., Cleveland. Estimated cost, $10,000. Noted Dec. 16.

The Western Automatic Machine Screw Co. has been granted a permit to construct a factory at Elyria, Ohio. Noted Dec. 2.

The Ironton Incandescent Stove Co. will construct a factory on front St., Ironton, Ohio. J. Davis is Mgr.

Preliminary plans have been prepared for the construction of a one-story, 50x200-ft. garage and repair shop for the city of Springfield, Ohio. Estimated cost, $20,000. R. C. Gotwald, 54 Gotwald Bldg., is Arch. Noted Dec. 2.

The American Seamless Tube Co. will construct a plant at Tiltonville, Ohio. Estimated cost, $2,000,000.

Frank W. Conrad will construct a 50x120-ft. garage on First St., Toledo, Ohio. Estimated cost, $15,000.

The Tillotson Mfg. Co., manufacturer of carburetors, will enlarge its plant at Jackson and 10th St., Toledo, Ohio.

The Toledo Furnace Co. plans to construct a blast furnace and steel plant at Toledo, Ohio. Estimated cost, $5,000,000.

The Willys-Overland Co. will construct a three-story, 100x100-ft. garage and service station at Adams and 14th St., Toledo, Ohio. Estimated cost, $100,000.

We have been advised that the Wapakoneta Machine Co., Wapakoneta, Ohio, is in the market for a punching and shearing machine. Noted Nov. 11.

The Ohio Corrugating Works plan to build a second addition to its plant at Warren, Ohio.

Plans are being prepared for the construction of a garage at Youngstown, Ohio, for James A. Campbell.

S. English has awarded the contract for the construction of two garages at Youngstown, Ohio.

The Trussed Concrete Steel Co. plans to construct a plant at Youngstown, Ohio, for the manufacture of all steel houses.

The American Rolling Mill Co. will improve its plant at Zanesville, Ohio.

The American Sewer Pipe Co. will construct a three-story, 50x96-ft. addition to its plant at Brazil, Ind.

The Crow Motor Car Co. is constructing an addition to its plant at Elkhart, Ind. Estimated cost, $10,000.

The International Steel and Iron Co. will construct a sheet metal plant at Evansville, Ind. Estimated cost, 70,000. Noted Nov. 18.

The contract has been awarded for the construction of a commercial garage and building at Ft. Wayne, Ind., for Aaron Shive, 1832 Thompson Ave. Estimated cost, $30,000.

The Standard Steel Forging Co. is constructing three additions to its plant at Hammond, Ind. Estimated cost, $100,000. Noted Nov. 25.

The Inland Steel Co. will expend about $5,000,000 for improving its plant at Indian Harbor, Ind.

We have been advised that the Indianapolis Drop Forging Co. is constructing an addition to its forge shop on Downey St., Indianapolis, Ind. Estimated cost, $2,000. Noted Dec. 9.

Bids have been received for the construction of a 54x200-ft. factory at Big Rapids, Mich., for the Fitch Drive Tractor Co.

The New York Board Manufacturing Co. will construct an addition to its plant at 214 Brady St., Detroit, Mich. Estimated cost, $1,000.

Bids are being received for the construction of a 40x110-ft. addition to the foundry of the Dake Engine Works at Grand Haven, Mich.

The Ford Motor Co., Detroit, Mich., will construct an addition to its plant at Highland Park, Mich. Estimated cost, $1,000,000. Frank L. Klingensmith, Detroit, is Vice-Pres.

The Perfection Spring Co. plans to construct a 36x150-ft. addition to its plant at Jackson, Mich.

The Goodale Co., recently incorporated with a capital of $60,000, will build a foundry at Kalamazoo, Mich.

The Lansing Foundry Co. will construct a 70x100-ft. addition to its plant at Lansing, Mich. Estimated cost, $10,000.

The Belvidere Screw and Machine Co. will construct a factory at Belvidere, Ill.

Plans being prepared for a four-story factory at Chicago, Ill., for the American Ever-Ready Works, manufacturer of electrical novelties.

The contract has been awarded for the construction of a one-story garage at 5016 Cottage Grove Ave., Chicago, Ill., for Louis Neroman. Estimated cost, $18,000.

The contract has been awarded for the construction of a one-story, 101x145-ft. garage at Chicago, Ill., for the Ogden Auto Sales and Garage Co. Estimated cost, $20,000. Noted Nov. 18.

The Regensteiner Colortype Co. awarded the contract for the construction of a two-story addition to its plant at 310 South Racine Ave, Chicago, Ill. Estimated cost, $25,000.

The Rosenberg Iron and Metal Co., 1462 Blue Island Ave., Chicago, Ill., will construct a one-story addition to its plant. Estimated cost, $15,000.

C. A. Schorff will construct a one-story, 100x250-ft. garage at 5210 Berkeley Ave, Chicago, Ill. Estimated cost, $20,000.

C. Wright, Muskegon, Mich., will construct a garage at 4868 North Clark St., Chicago, Ill. Estimated cost, $26,000. I. C. Saxe, 127 North Dearborn St., Chicago, Arch.

Bids will soon be received for the construction of a garage and machine shop at Fond du Lac, Wis., for J. W. Watson. Estimated cost, $15,000.

Bids will soon be received for the construction of a two-story, 56x115-ft. garage at Manitowoc, Wis., for H. W. Hagen & Co. Noted Dec. 23.

The plant of the Felker Manufacturing Co., manufacturer of steel culverts, well casings, silo fillers, etc., at Marshfield, Wis., which was recently destroyed by fire with a loss of $20,000 will be rebuilt. A. G. Felker is Pres.

Plans are being prepared for the construction of a foundry at Milwaukee, Wis., for the Electric Steel Casting Co.

Fire, Dec. 10, damaged the plant of the Power and Machinery Co., Milwaukee, Wis. Loss, $1,000. J. O. Bird is Pres.

Plans are being prepared for the construction of a one-story factory at Oshkosh, Wis., for the Warming Sheet Metal Co. Estimated cost, $4,000.

The Hamilton-Beach Mfg. Co., manufacturer of electrical appliances and devises, is constructing a plant at Racine, Wis. Noted Oct. 14.

The contract has been awarded for the construction of a one-story foundry at West Allis, Wis., for the Sawyer Steel Cast Co.

WEST OF THE MISSISSIPPI

Press reports state that Charles B. Elliot, agent for the Ford Motor Co., plans to build a two-story brick garage at West Mills and Maple St., Creston, Iowa. Estimated cost, $15,000.

The Sheldon Fixture Co., Estherville, Iowa, will build a factory, 60x280 ft. Estimated cost, $16,000.

The Kelly Mfg. Co., manufacturer of steel tanks, Waterloo, Iowa, has awarded the contract for rebuilding its plant which was destroyed by fire. Noted Oct. 7.

The American Can Co., 747 North Prior Ave., St. Paul, Minn., will build an addition to its plant in the Midway District. Estimated cost, $100,000.

Bids will be received by August Hohenstein, Pur. Agt., City Hall, until noon, Jan. 3, for tools and machinery to equip the municipal garage in St. Paul, Minn.

The Chevrolet Motor Car Co., Flint, Mich., will build an assembling plant at St. Paul, Minn. Estimated cost, $300,000.

The Lead Coating Mfg. Co. will build a plant at Berry and Pearl St., St. Paul, Minn. Estimated cost, $100,000.

The Swanson St. Joseph Plow Mfg. Co., Overland Park, Kan., will build a factory. Estimated cost, $15,000. H. S. Swanson, Pres.

The R. S. Mentro Co., Anaconda, Mont., plans the construction of a commercial garage and machine shop at Main and Third St., Anaconda. Hyslop & Westcott is Arch.

The Brilliant Sign Co. purchased site at St. Louis, Mo., and will build a four-story plant.

The Osage Iron and Steel Co., Sand Springs, Okla., Will build factory for manufacturing metal into reinforced steel. Estimated cost, $65,000.

We have been informed that the Farm Engineering Co., Sand Springs, Okla., will start work about Jan. 1 on a factory for the manufacture of farm tractors. Machine tools and heat treating equipment will be required. Noted Dec. 9.

Mitchell & Crosbie will construct a garage and machine shop at Tulsa, Okla.

The Weaver Investment Co., Pueblo, Colo., will build a garage on Ninth St. Estimated cost, $25,000. R. J. Weaver, Pres.

WESTERN STATES

The Campbell Hardware Co. plans to construct a garage and machine shop at Bellevue and Pine St., Seattle, Wash. Estimated cost, $15,000. David Dow, 21st and Spruce St., Seattle, is Arch.

The T. F. Clark Co., 604 Railroad Ave., Seattle, Wash., will construct a plant at Seattle, for the manufacture of ornamental iron work.

The Kissel Car Automobile Co. has awarded the contract for the construction of a two-story garage and salesroom at Broadway and Davis St., Portland, Ore. Estimated cost, $25,000. Noted Oct. 14.

The Pacific Canning Machinery Co., Long Beach, Calif., recently incorporated, plans to construct a plant at Long Beach for the manufacture of can openers.

Herman Weysser, 1476 36th Drive, Los Angeles, Calif., plans to construct a garage and machine shop at 439 South Flower St.

H. F. Whittier, 927 South Hill St., Los Angeles, Calif., plans to construct an automobile repair plant at 1234 South Olive St.

American Machinist

L. P. ALFORD, *Editor*

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JIGS USED ON MAGNETO PARTS AND A MOTOR DETAIL 1151
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NUMBER OF COPIES PRINTED THIS ISSUE, 21,900

This includes the English Edition. None sent free regularly, no returns from news companies, no back numbers.

Talks With Our Readers

By the Publisher

YOU have this issue of the American Machinist in your hands. You know that it contains articles of interest to you, but do you realize what a large amount of information of direct bearing on your work is published each year in the American Machinist? Few of us do; and that's why I believe that once a year, at least, it's a good plan to take an inventory and see exactly what we have had.

One of the strong points about the American Machinist is that it is published from the field. That is, the editors spend practically all their time in the field, rather than in the office, thus making the American Machinist a mirror of what is actually being done. They have certainly been on the job this year, having traveled 39,500 miles.

From our valued contributors we have received 2,200 articles. 960 were returned because they were not in our line, the subject had been covered before or they were not of our readers' standard. There have been published a total of 2296 pages, the interest value of which was enhanced by the use of 2,908 halftone and 2,643 line cuts.

There Have Been

General Articles .....915 Editorials 270
Letters, Discussions ....734 New Tools 425
New and Enlarged Shop Items ..8,972

This material is equivalent to more than twenty 250-page technical books. And it is more accurate and uptodate than any technical book can possibly be. All phases of machinery design and building have been dealt with. Let's classify some of this:

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Our Information Bureau has received 1,292 letters asking for specific information. To each of these we have endeavored to give as complete answers as possible.

Announcements of 825 different concerns have appeared in the buying section—advertisements, most of which have contained real information, furnishing a reliable, interesting and uptodate marketplace for the progressive busy man.

There have been 3,363 Help and Situation Wanted advertisements in our classified columns—a guide to the good men out of a job and to the concerns that want high-class men.

ALL of this shows how thoroughly the American Machinist covers the subjects of vital interest to every live, progressive machine-shop man and how it truly represents the great industry of which it is the recognized, leading mouthpiece.

Immediate Delivery

NILES CRANES

Subject to prior sale we offer the following new Cranes

15-ton,* 55 ft. span, 220 volts, D. C.

Three Motors. Girders, box section. Hoist and bridge motors, 24 H.P. Trolley motor, 4 H. P. Speeds with full load (feet per minute) bridge, 275; hoist, 15; trolley, 100; Height, top of runway rail to top of crane, 5 ft. 11 in. Distance from center of runway rail to end of crane, 8 in.

15-ton,* 36 ft. 6⅝-in. span, 220 volts, D. C.

Three Motors. Girders, box section. Hoist and bridge motors, 24 H. P. Trolley motor, 4 H. P. Speeds with full load (feet per minute) bridge, 250; hoist, 15; trolley 100; Height top of runway rail to top of crane, 5 ft. 8 in. Distance from center of runway rail to end of crane, 7 in.

20-ton, 5-ton auxil. hoist, 36 ft., 6⅝ in. span, 220 volts, D. C.

Four Motors. Girders, box section. Main and auxiliary hoist and bridge motors, 24 H. P. Trolley motor, 8 H. P. Speeds with full load (feet per minute) bridge, 250; main hoist, 12; auxiliary hoist, 40; trolley, 100; Height, top of runway rail to top of crane, 6 ft., 4 in. Distance from center of runway rail to end of crane, 8 in.

20-ton (two 10-ton trolleys) 36 ft., 6⅝ in. span, 220 volts, D. C.

Five motors. Girders, box section. Hoist and bridge motors, 24 H. P. Trolley motors, 4 H. P. Speeds with full load (feet per minute) bridge, 250; hoists, 20; trolleys, 100; Height, top of runway rail to top of crane, 5 ft. 8 in. Distance from center of runway rail to end of crane, 7 in.

*May be equipped with 3½ ton auxiliary hoist.

If necessary slight changes can be made in the span or other dimensions in a reasonable time.

——→If you are interested we suggest that you telegraph us at once.←——

Niles-Bement-Pond Company

111 Broadway, New York

Freedom From Chatter

THAT'S the point strongly brought out by the picture of this 36" Motor-Driven Lodge & Shipley Lathe handling heavy chucking work with great overhang beyond the face-plate jaws.

The solidity of the headstock, the stiffness and size of the lathe spindle, and the method of tool support make it possible to perform overhanging operations of this character without chatter.

Lodge & Shipley Lathes lend themselves especially well to individual requirements of hard or unusual service.

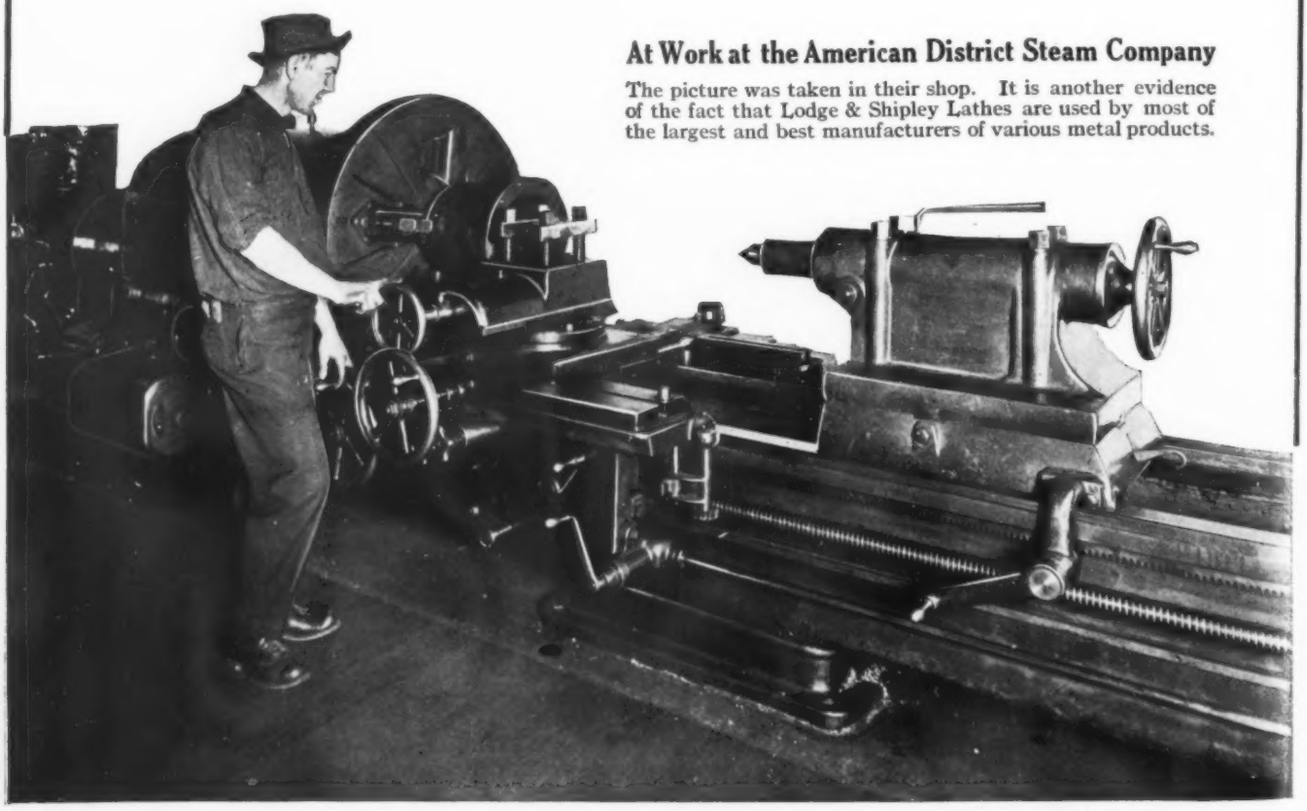
LATHES
GOOD LATHES ONLY
TRADE MARK

They are flexible in their ability to adapt themselves to the work in hand, accomplishing results with efficiency and economy.

THE LODGE & SHIPLEY MACHINE TOOL CO.

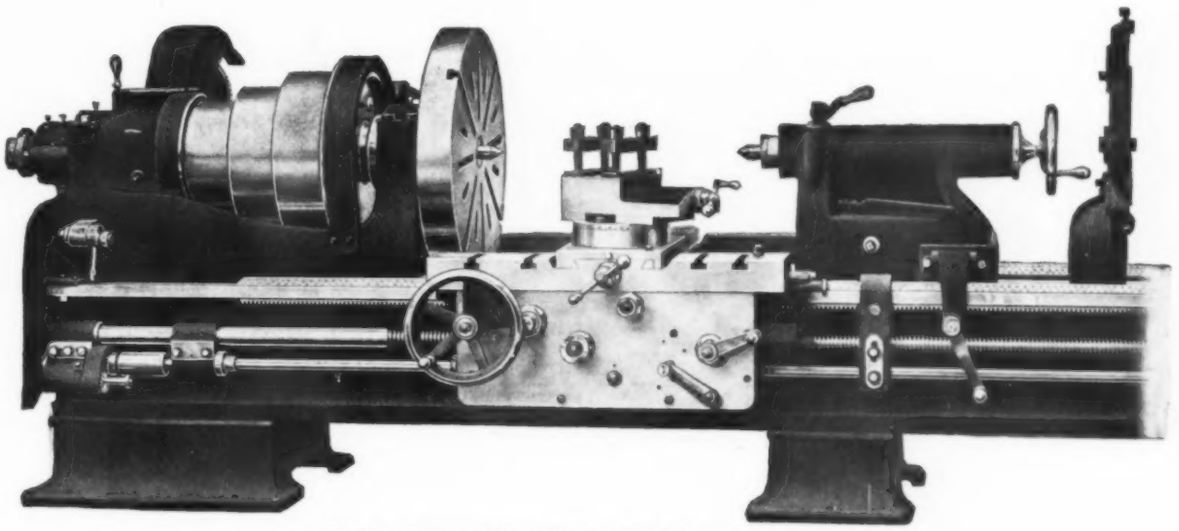
Cincinnati, Ohio

DOMESTIC AGENTS—Brown & Zortman Machinery Co., Pittsburgh; Charlotte Supply Co., Charlotte; Colcord-Wright Machinery & Supply Co., St. Louis, Dewstoe Machine Tool Co., Birmingham; Galigher Machinery Co., Salt Lake City; Hallidie Machinery Co., Seattle; The Hallidie Co., Spokane; Harron, Rickard & McCone, San Francisco, Los Angeles; Hendrie and Bolthoff Mfg. & Supply Co., Denver; Kempsmith Machinery Co., Baltimore; Marshall & Huschart Machinery Co., Chicago, Indianapolis; Motch & Merryweather Machinery Co., Cleveland, Detroit; C. T. Patterson Co., Ltd., New Orleans; Prentiss Tool & Supply Co., New York, Boston, Buffalo, Syracuse, Rochester; Robinson, Cary & Sands Co., St. Paul, Duluth; Seeger Machine Tool Co., Atlanta, Ga.; W. E. Shipley Machinery Co., Philadelphia; Zimmerman-Wells-Brown Co., Portland, Ore.



At Work at the American District Steam Company

The picture was taken in their shop. It is another evidence of the fact that Lodge & Shipley Lathes are used by most of the largest and best manufacturers of various metal products.



32-Inch Bradford Standard Engine Lathe

The Extra Service of "Bradfords" Results from Extra Features—Extra Materials and Extra Workmanship

Bradford Lathes of any swing from 14" to 42" are properly proportioned in every feature for the work to be handled.

Even among the heavy lathes, including the 32-inch Engine Lathe illustrated, the conveniences for operating the machine have not been lost in the design. Thus, work demanding rapid manipulation can be executed with the utmost dispatch.

An extra thickness of metal in the Bed, Head, and Tailstocks, Carriage and other heavy parts, insures rigidity.

Give the subject of lathes proper thought before making a purchase. Investigate them all—start in with "Bradfords" by sending for special Circulars.

The Bradford Machine Tool Company

Cincinnati, Ohio, U. S. A.

DOMESTIC AGENTS—Swind Machinery Co., Philadelphia, Penn. Taylor Machinery Co., Boston, Mass. Somers, Fitler & Todd Co., Pittsburgh, Penn. The H. A. Stoker Machinery Co., Chicago, Ill. Pacific Tool & Supply Co., San Francisco, Calif. The Mine & Smelter Supply Co., Denver, Colo. The E. A. Kinsey Company, Cincinnati, Ohio, Indianapolis, Ind. Hill, Clarke & Co., New York, N. Y.

Modern Milling on the Cincinnati Miller

Heavy and Accurate Cuts

The illustration shows a Cincinnati No. 5 Plain High Power Milling Machine, belt connected to a 35 H. P. motor, taking the heaviest recorded cut ever handled by a Knee and Column Milling Machine.

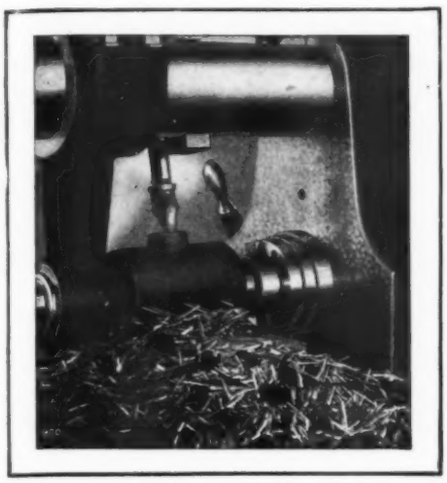
The removal of 37½ cubic inches of steel on this machine was a frequent performance in our Demonstrating Room, during a period of nine months. As an evidence that this heavy stress did not impair the accuracy of the machine, the pieces shown in photograph 854 (opposite page) were milled without a single adjustment.

The motor regularly furnished with the machine has 20 H. P. This cut consumed 42 H. P., indicating the large factor of safety we allow for the protection of our customers.

This machine was equipped with our patented stream lubrication system which pumps a large quantity of cutting compound into a hood, surrounding the cutter, thus keeping the cutter constantly immersed in a rapidly flowing volume of compound. The result is faster milling with heavier cuts, and longer life of cutters, because the heat is carried away as fast as generated.

It is interesting to compare this performance with the removal of 12½ cubic inches per minute which was a maximum cut on the same size machine in 1908. The figures given below will indicate the marked increase in the cutting capacity of Cincinnati Millers resulting from the many recent improvements as described in our advertisements.

	1915	1908
Size Machine	Cincinnati No. 5	Cincinnati No. 5
Material—steel	55,000 lbs. tensile	55,000 lbs. tensile
Width of piece	5″	4″
Depth	⅜″	3/16″
Feed	20″	16″
Diameter of cutter	3¼″	3¼″
Chip removal in:		
Cubic inches per minute	37½	12
Cubic inches per hour	2,250	720
Pounds per hour	560	180
Horsepower	42	27
Cubic inches of chips per H. P.	89	44



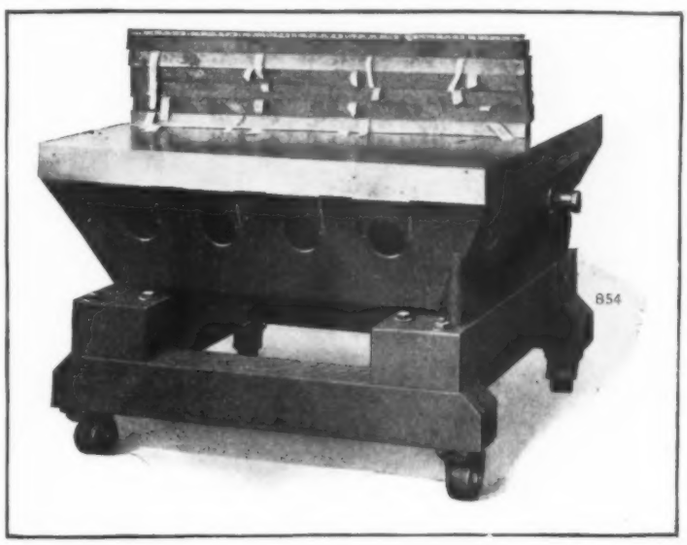
This is an increase of over 200%. The increase in the cubic inches of chips per horsepower is also interesting. This is due in part to the greater efficiency of the Cincinnati design cutter used.

It is one of our Wide Spaced Design, developed in our shop after years of experimentation. The teeth are set at an angle of 25° with 15° undercut. The chips have a clean cut surface resulting from the shearing action of the cutter instead of the pushing action of the ordinary cutter without rake.

We recommend wide spaced, wide angle cutters, with rake, for all purposes.

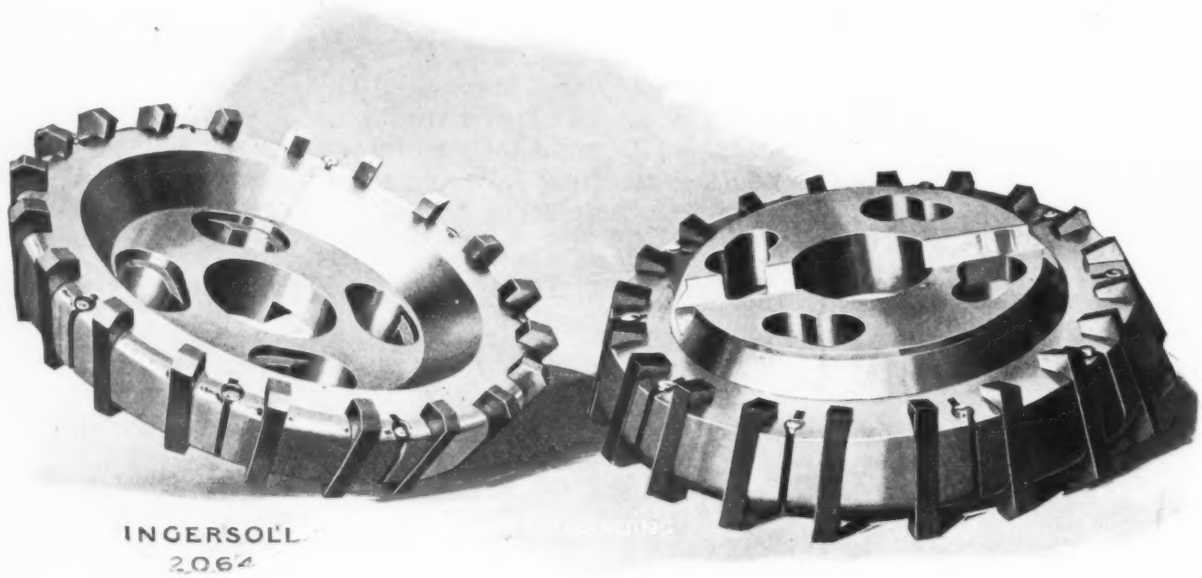
These are the bars milled on this No. 5 Machine after nine months of heavy service. They are 42 inches long and 4 inches wide. Two were milled with a spiral mill, mounted on the arbor of the machine; two with a shell end mill in the spindle of the Vertical Attachment; two with the same mill in the spindle of the machine. Machined on both sides all six surfaces, showed flat within .001, each holding tight eight pieces of tissue paper. Until recently, the milling machine has not been considered suitable for long, accurate flat work.

This shows not only that it can do such work, but that a properly designed and strong machine like the Cincinnati can do it accurately after a long period of continuous heavy service.



Our pamphlet, "Cold Chips" tells about this and other interesting facts concerning Cincinnati High Power Millers.

THE CINCINNATI MILLING MACHINE COMPANY
Cincinnati, Ohio, U. S. A.



Ingersoll Milling Cutters

Are "Up-to-the-Minute" in Design

Do You Get the quick detachable method of holding the above? These are made for high production work in the automobile field.

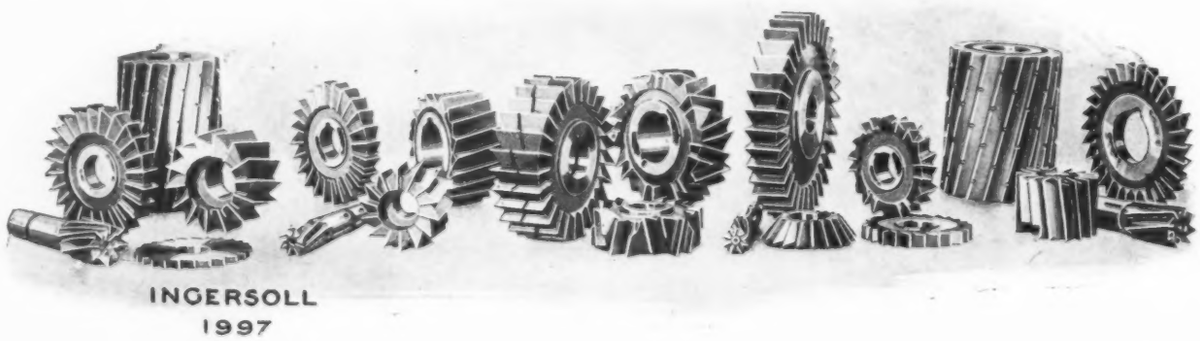
Catalogue No. 30-C for Standard Cutters.

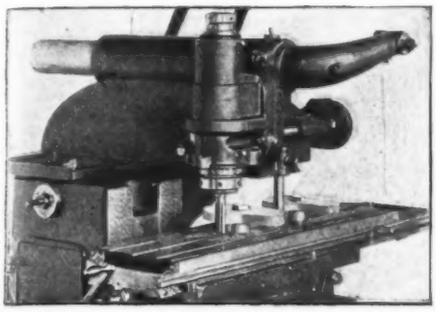
We also take the pride of a specialist in developing cutters for any and all unusual conditions. Tell us your Cutter Troubles.

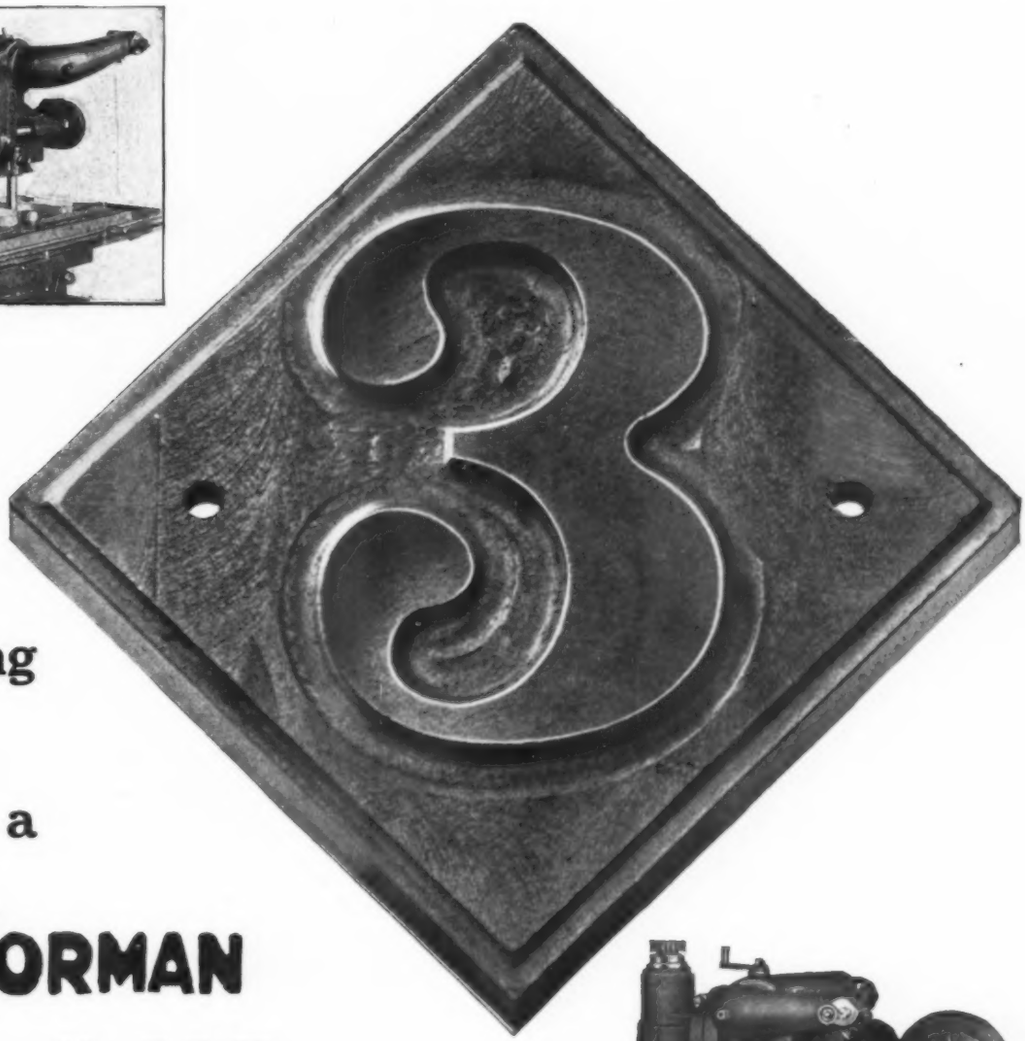
The Ingersoll Milling Machine Company

Main Office and Works: ROCKFORD, ILL., U. S. A.

We have a large stock of High Speed Steel, and can make prompt deliveries.







Duplicating Irregular Forms on a

VAN NORMAN "Duplex" Miller

There's a Profile Stud on all No. ½ and No. 2 "Duplex" Millers with which you can duplicate all sorts of cams and other irregular figures.

The figure "Three" shown above was routed out in this manner. The small cut at the top of this page suggests how it was done.

Clamp your pattern and your blank on the table and merely keep the Profile Stub touching the pattern. Once around and the job is done.

All Van Norman "Duplex" Millers are combination vertical and horizontal machines.

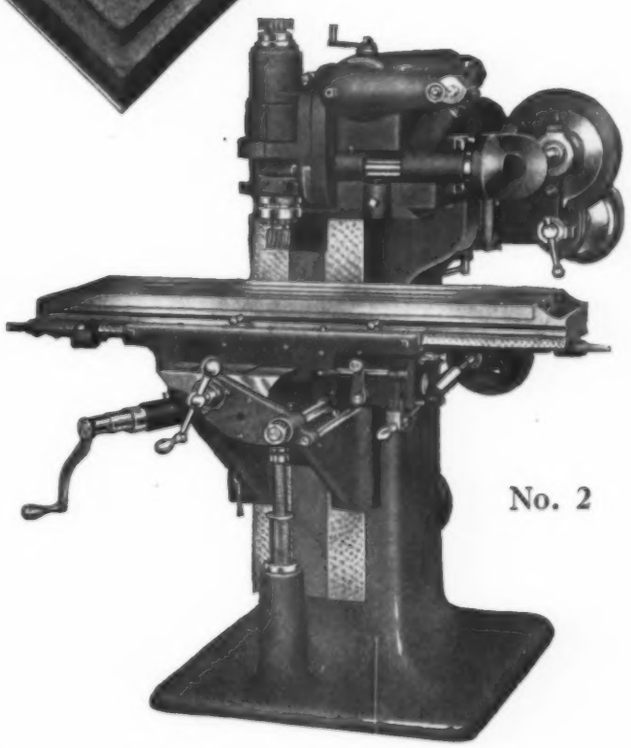
Besides this the head may be clamped in any tilted position between vertical and horizontal, and in this way all manner of angles may be had.

Jigs and fixtures are unnecessary. The work remains fixed.

For tool rooms, for repair work, for everything with the possible exception of heavy slab milling.

We have three sizes—a larger machine than that shown and a smaller one.

Write for our printed matter.

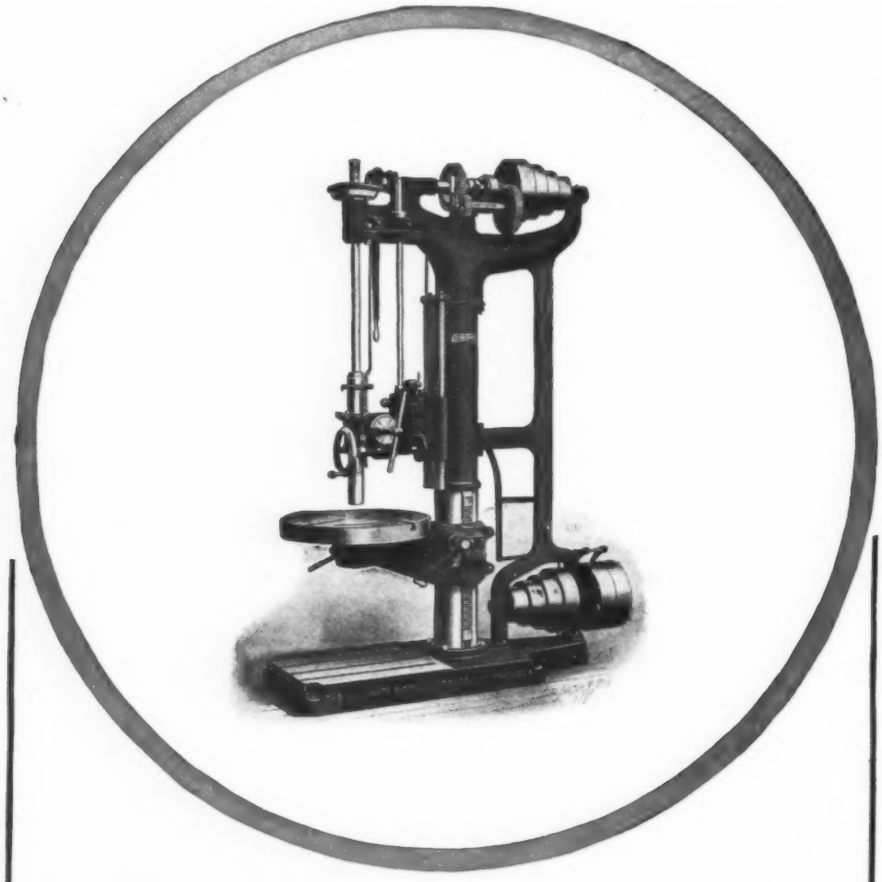


No. 2

Van Norman Machine Tool Company

Wilbraham Avenue - - Springfield, Mass., U. S. A.

Agents for Great Britain, Alfred Herbert, Ltd.



THE CINCINNATI

24" to 42" Heavy Pattern Upright Drilling Machine

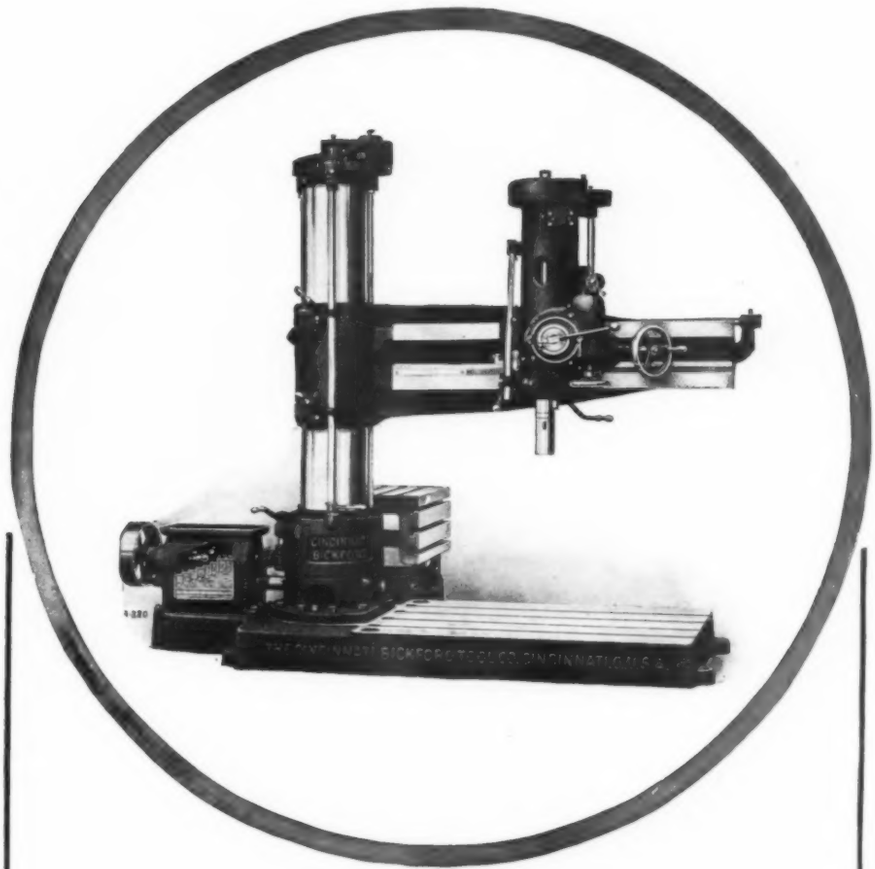
The Head is adjusted by a steel rack and pinion, is provided with convenient means for compensating for wear on the spindle sleeve, is counterbalanced by a weight inside the column, and is readily clamped wherever it is placed.

The Feeds number six, are positive and instantly available. The gearing is of steel and is incased in a box mounted on the head. The handles for changing feeds are stamped in large figures to show the advance of the spindle in thousandths per revolution and are located so as to be always within full view and convenient reach.

The Cincinnati Bickford Tool Co.,

DRILLING MACHINERY FOR BOTH HIGH

U288



THE CINCINNATI BICKFORD

4, 5 and 6 Ft. Regular Plain Radial Drilling Machine

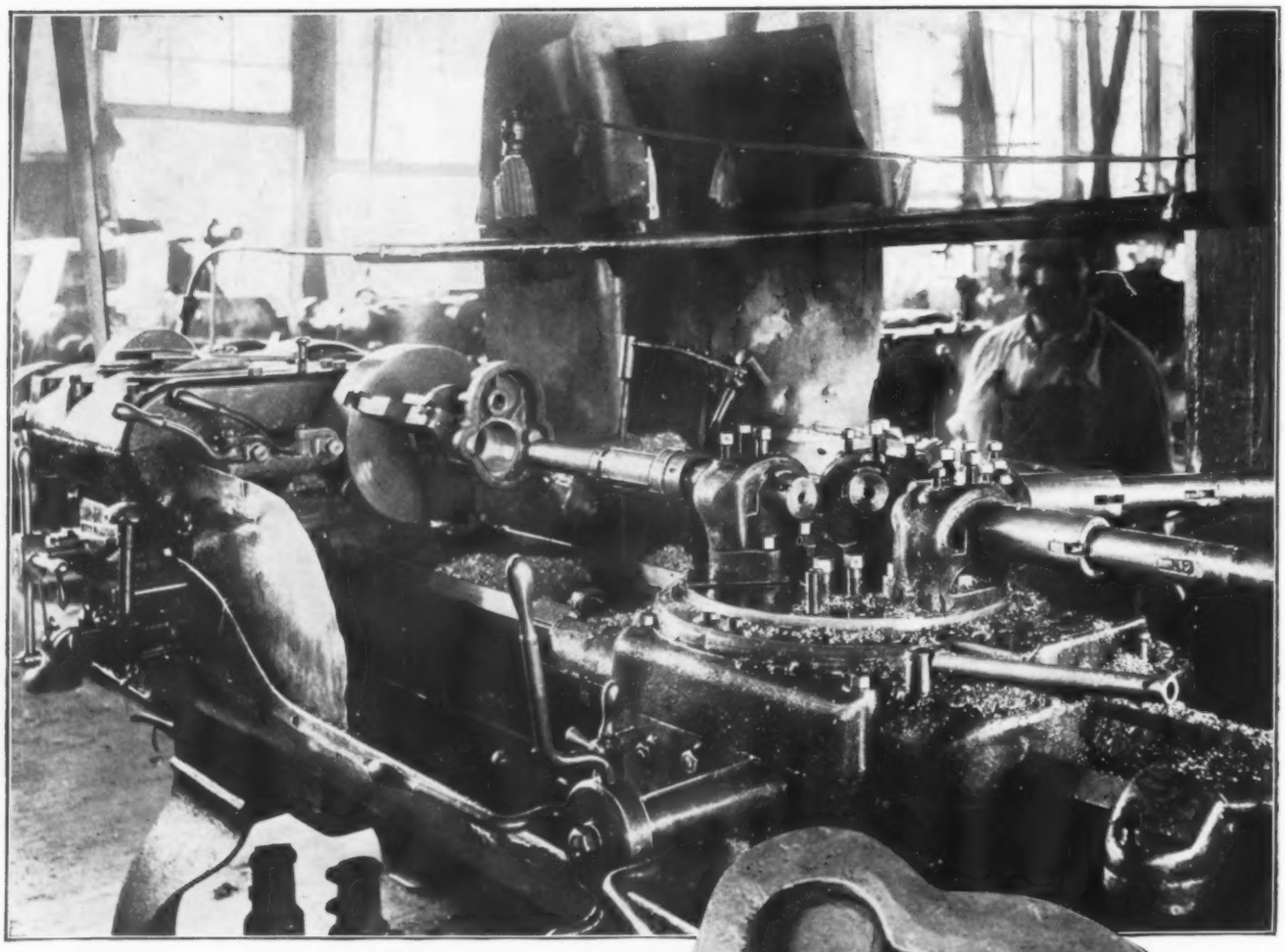
The arm is of most improved design, extremely stiff, providing generous support and long guide way for head. The elevating mechanism for arm is protected against breakage through the use of our new interlocking device (patent recently allowed) which prevents elevating gearing being engaged until the arm is unclamped.

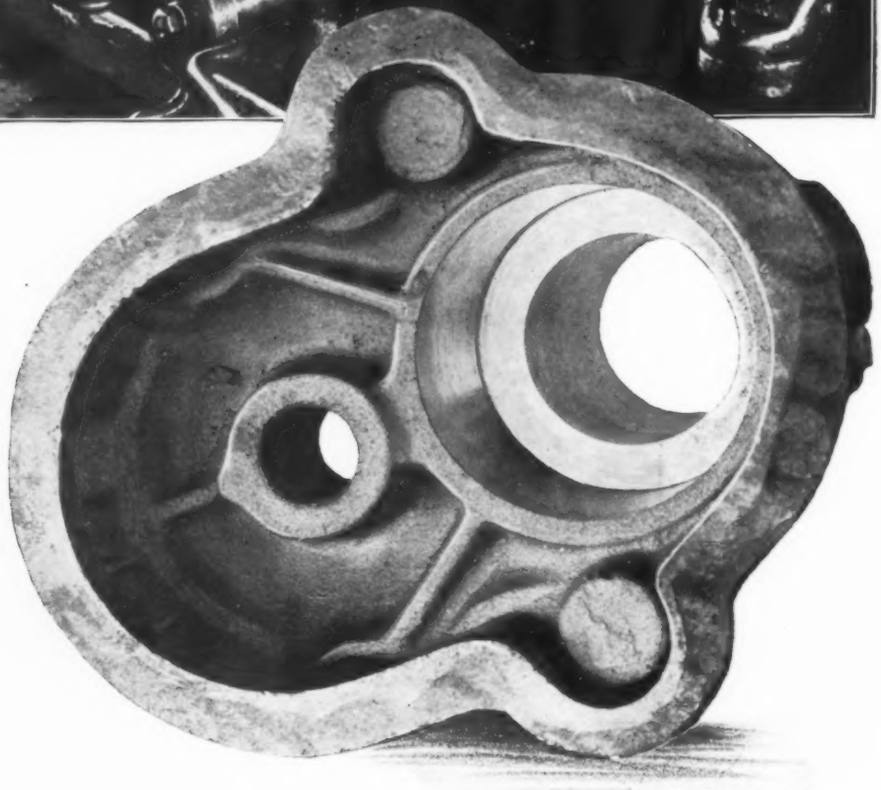
The back gear and friction clutch levers are both at bottom of head where it is convenient for the operator to lower the speed of the spindle when making back gear speed changes, relieving the gearing of clash and damage. The advantageous position of these levers is much appreciated when arm is used in a high position.

Oakley, Cincinnati, Ohio, U. S. A.

SPEED AND ORDINARY TWIST DRILL USE

R288





Ten of these per hour—

and they meet the Chalmers requirements—

These photographs were taken in the Chalmers plant in September. They represent not demonstration work, but every-day output—the day after day output when the human element strikes its medium—when the pace settles down to the steady dog-trot—when the Hartness Flat Turret Lathe shows not what it *can* do, but what it does do right along, continuously, month in and month out.

With these facts in mind consider this job:

Transmission end cover—aluminum—2 borings, 2 reamings, 1 facing. Output 10 per hour.

This was on the Single Spindle Hartness Flat Turret Lathe. Why not consider this machine for your work? Once more let us review those familiar features which make the production quoted possible—easily possible.

The Flat Turret which holds every tool securely, and brings it against the work in the same unvarying position, hour after hour. The Cross Sliding Head (exclusive) which gives *every* turret tool a cross feed, if necessary, and reduces the tool outfit to the utmost of simplicity and stiffness.

12 Carriage Stops control all longitudinal movements of cutting tools.
9 Cross-Sliding Head Stops control all lateral movements of cutting tools.

9 Spindle Speeds insure peripheral correct cutting speeds regardless of diameters or material being worked.
9 Different Feeds insure the correct amount of chip for every kind of cutting operation.

6 Turret Positions.

The Single Spindle Flat Turret Lathe is made in two sizes and is used for both bar and chucking work.

JONES & LAMSON MACHINE CO.
Springfield, Vt., U. S. A. and 97 Queen Victoria Street, London, E. C.

Germany, Holland, Switzerland and Austria-Hungary: M. Koyemann, Charlottenstrasse, 112 Dusseldorf, Germany.
France, Spain and Belgium: F. Auberty & Co., 91 Rue de Maubeuge, Paris.

HARTNESS FLAT TURRET LATHE

An "Unusual Request"—

Incidentally, one of the most unusual recommendations you ever read—

STRAIGHT from the shoulder from a man who has had actual experience on an "American" Lathe day in and day out for the past two years.

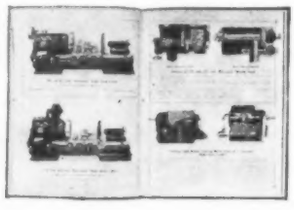
Read his letter. It won't take you long. No theoretical arguments are necessary from us to support this case. He states the cold facts in plain language that needs no supplementing.

"It is the most accurate and efficient lathe I ever worked on"—and that from a lathe operator.

Could he possibly have said more for the machine? Could he possibly have paid it a higher tribute than by writing clear into Cincinnati to find a position operating another "American" lathe? Just stop a moment and realize the significance, the value of such a feeling among your operators. Give your men a machine they will like, one they can easily understand and operate, one they can make time on and you will have a combination that fairy spells **production.**

That, gentlemen, is why "American" lathes are in such demand. That is why so many shop officials insist on "American" and will even wait for them when necessary, even though other makes could be secured immediately; because they know their men will be satisfied, their work good, production increased and the results thoroughly satisfactory to the firm.

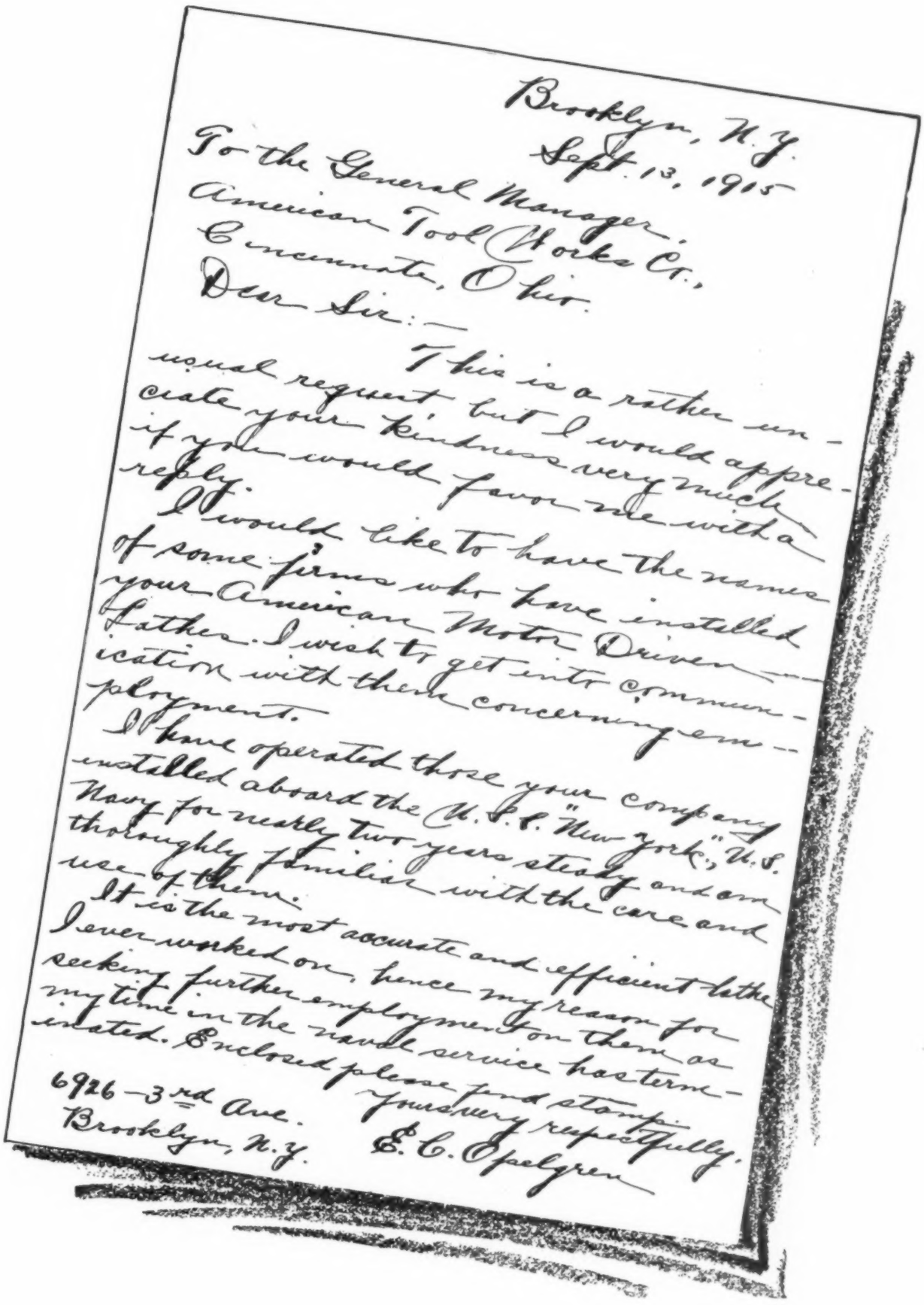
You cannot make a more profitable move right now than to write for our Efficiency Bulletin. Look it over, then hand it to your Superintendent or head foreman. It will surely interest them.



The American Tool Works Co.

Cincinnati, U. S. A.

Lathes **Planers** **Shapers** **Radials**



Brooklyn, N.Y.
Sept. 13, 1915

To the General Manager,
American Tool Works Co.,
Cincinnati, Ohio.

Dear Sir:—

This is a rather unusual request but I would appreciate your kindness very much if you would favor me with a reply.

I would like to have the names of some firms who have installed your American Motor Driven—— Lathes. I wish to get into communication with them concerning employment.

I have operated those your company installed aboard the U.S.S. "New York", U.S. Navy for nearly two years steady and am thoroughly familiar with the care and use of them.

It is the most accurate and efficient lathe I ever worked on, hence my reason for seeking further employment on them as my time in the navale service has terminated. Enclosed please find stamp.

Yours very respectfully,
E. C. Opelgren

6926—3rd Ave.
Brooklyn, N.Y.

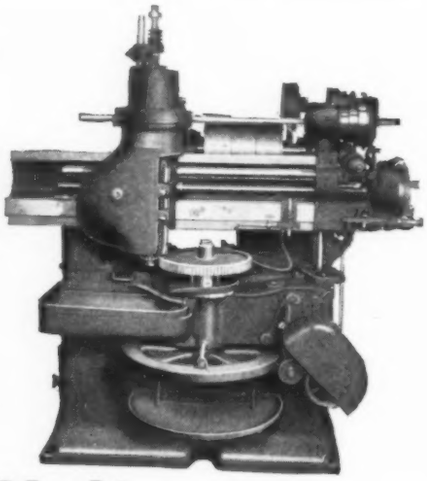
The Tool—

A Generated Cutter—

Each one is an "original." Each is ground **after** hardening. In that way the distortions which almost invariably follow the plunge into the heating furnace are removed.

Finally, each one has its pure involute teeth tested on an instrument which detects errors in ten-thousandths of an inch.

That is the Fellows Gear Shaper Cutter.



The Machine—

A machine that is built around the cutter, holding it locked within a rigid grasp.

A machine that asks but little of its operator. The cutter is placed on the spindle of the machine and locked in place by a nut. The gear blanks are placed on the work spindle. The machine is set for length and position of stroke—very simply and easily without complications of any kind.

The machine is started.

No further attention is asked from the operator till a bell rings announcing the gear is finished.

That's the Fellows Gear Shaper.

THE FELLOWS GEAR SHAPER CO.
SPRINGFIELD, VERMONT, U. S. A.

Fellows Gear Shaper

The Product—

A gear in which is reproduced to a remarkable degree the pure, almost perfect (remember that inspection test)! involute teeth of the cutter which generated it. Therefore an accurate gear.

A gear which is cut in time so brief that before the advent of this method it was considered impossible. Therefore an accurate gear commercially produced.

That is the product of the Fellows Gear Shaper.

And You—

?

And you the manufacturer, are the fourth essential.

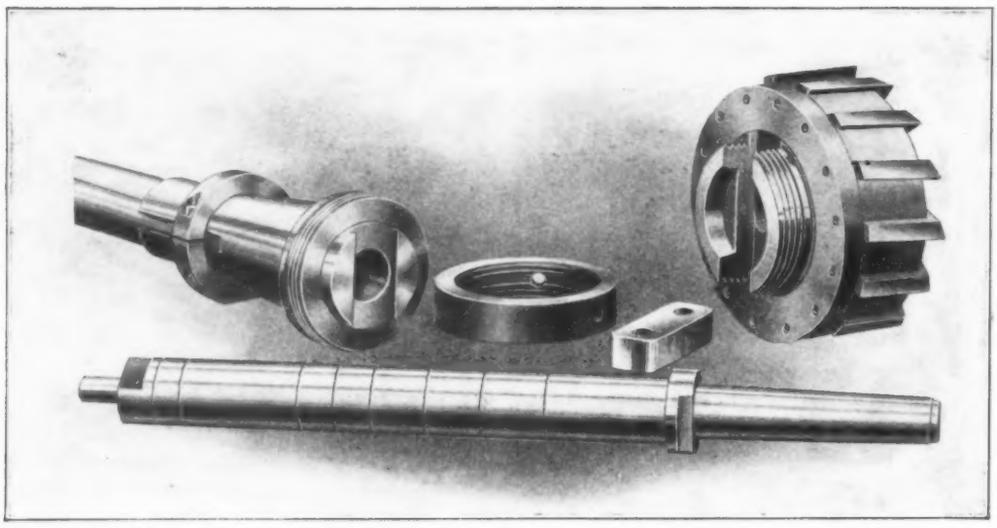
We want to offer you further proof that here is the means of obtaining accurate gears in commercial quantities.

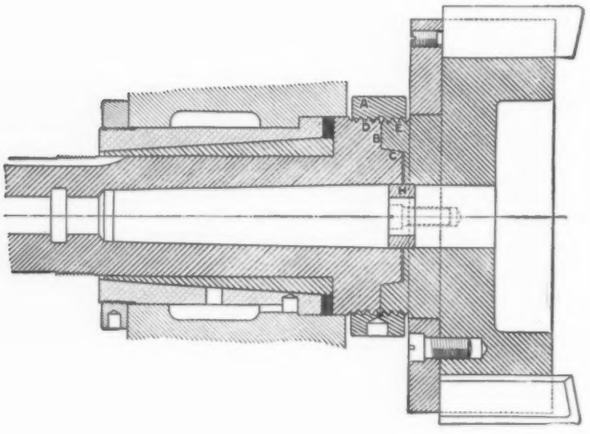
Without your cooperation, the machine, no matter how good it is, is useless.

With your cooperation it will set a new standard of accurate and rapid gear-making in your shop.

Will you cooperate?

"A treatise on Commercial Gear Cutting" will be sent you for the request. Eighty-five pages of practical information.





Describing The Patented KEMPSMITH Spindle Nose Construction

Patented July 21, 1914

Every Kempsmith Plain and Universal Milling Machine is now regularly equipped with our patented spindle nose construction shown above.

It provides a positive drive for both right hand and left hand face milling cutters, and also provides a ready means of removing cutters regardless of how long it has been on.

The line drawing shows how simple the whole thing is, and the following description tells just how it works:

The spindle nose is threaded right hand at "D" and the face milling cutter is threaded left hand at "E." The hardened steel nut "A" is threaded half right hand, half left hand.

The spindle nose is provided with a taper boss at "C" which centers the cutter.

The hardened steel key "H" drives the cutter in either direction, the steel nut "A" serving only to hold the cutter in position.

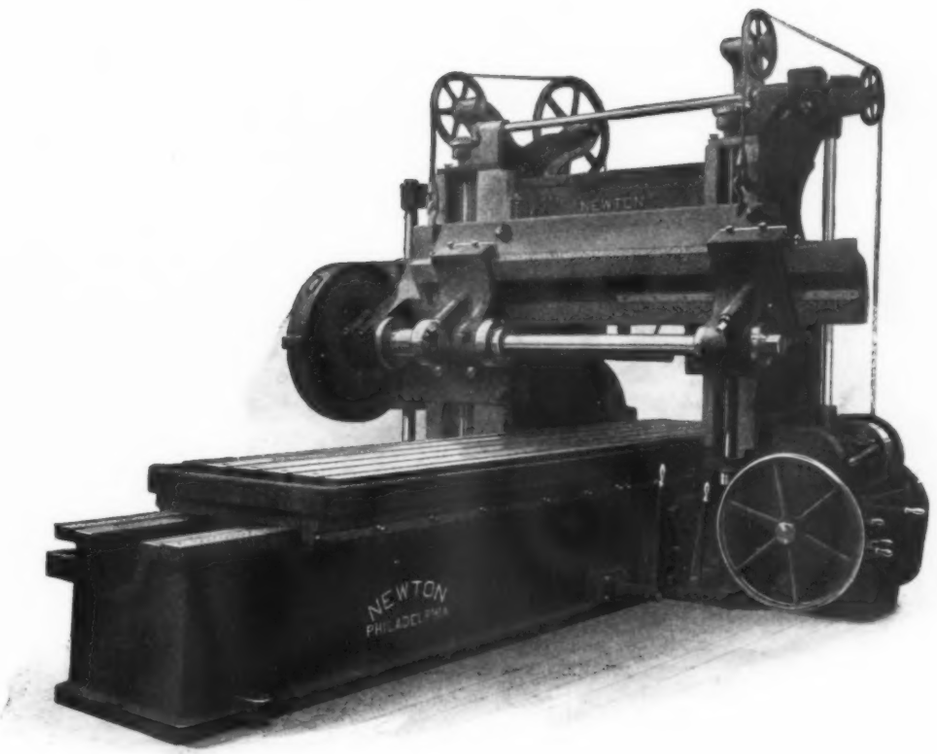
The advantages of this spindle nose construction are especially great in the case of a Vertical Milling Machine or Vertical Milling Attachment. The entire operation of attaching the cutter to the spindle is performed **above** the cutter. A complete description of this construction is contained in our circular No. 195.

The Kempsmith Mfg. Co.
Milwaukee, Wis.

Advertised continuously through the past thirty-three years

NEWTON

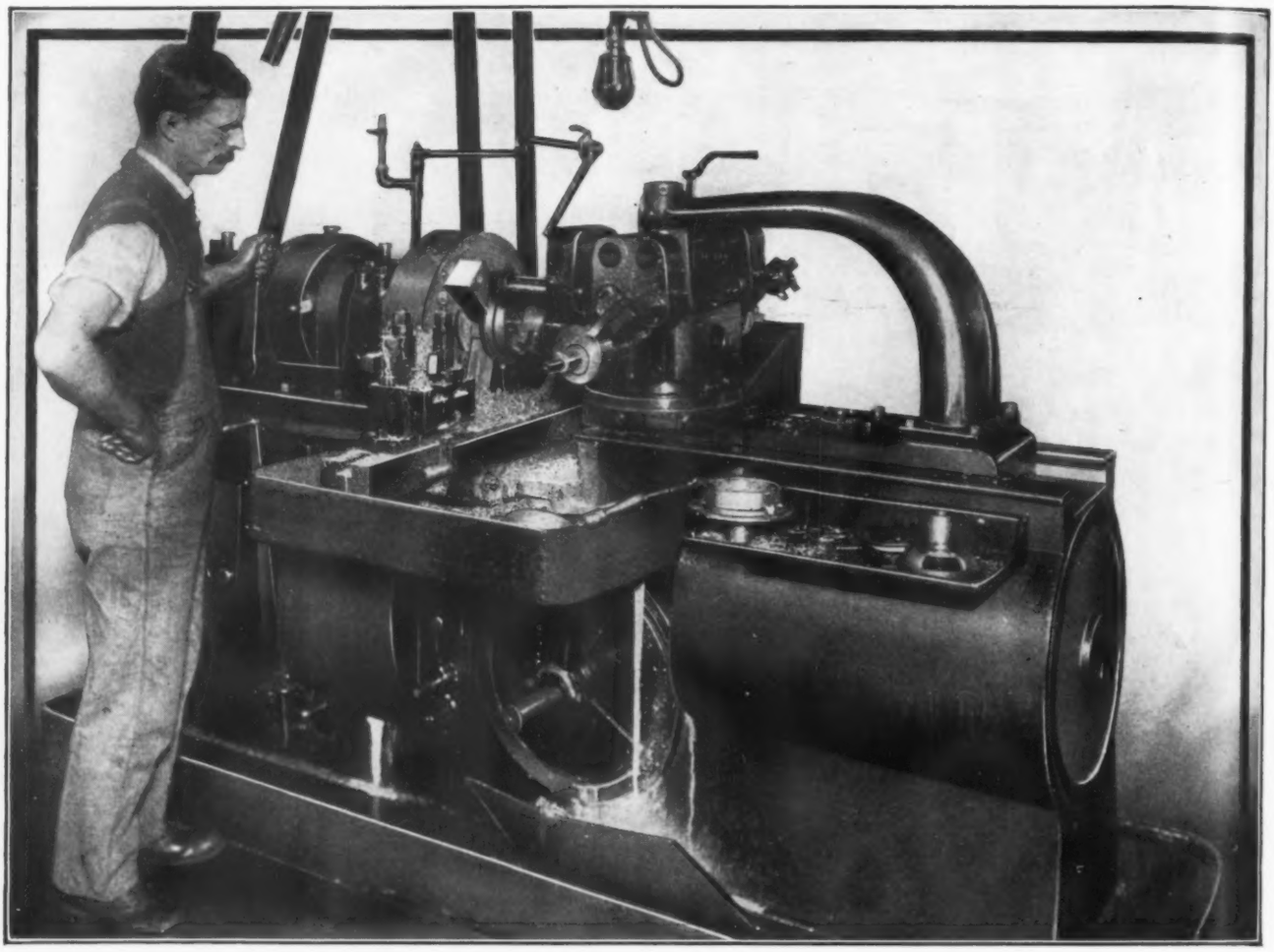
REGISTERED TRADE MARK



No. 5 Horizontal Milling Machine
36" wide table. Table to mill 14 feet. 42" between uprights.

Cold Saw Cutting Off Machines.
Locomotive Cylinder Boring Machines.
Horizontal Boring Machines. Crank Planers.
Vertical Milling Machines. Duplex Milling Machines.
Portable Boring, Milling and Drilling Machines.
Vertical Milling Machines.
Rail Ending Machines.
Floor Boring Machines. Rail Drilling Machines.

NEWTON MACHINE TOOL WORKS, Incorporated
23rd and Vine Streets, Philadelphia, U. S. A.



NEW PROCESS GEAR CORPORATION

SYRACUSE, N.Y.

Potter & Johnston Automatics are used in connection with the well-known products of the New Process Gear Corporation, Syracuse, N. Y.

The fact that Potter & Johnston Automatics are able to meet the production-requirements of such a plant is pretty good evidence of the efficiency and up-to-dateness of our machines.

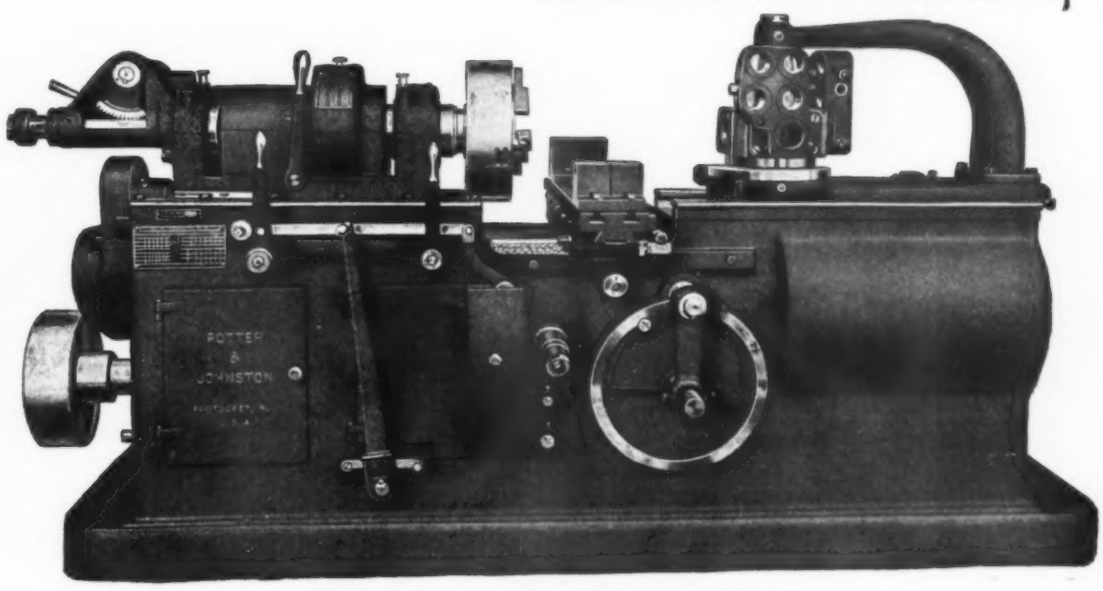
The "do-it-automatically" way is the profitable way to satisfy your customers on the quality and quantity basis.

POTTER & JOHNSTON

PAWTUCKET, R. I., U. S. A.

POTTER & JOHNSTON
MANUFACTURING AUTOMATICS

"Do it Automatically"



NEW MODEL 6-A MANUFACTURING AUTOMATIC

Look Forward to Greater Things in 1916—

By installing Potter & Johnston Automatics now, you can make 1916 a year of continuous production in your machining department.

One interruption to every 10 or more operations is more profitable than 10 interruptions for 10 operations, isn't it?

After Potter & Johnston Automatics have been set up for the work in hand, the human element is minimized almost to the point of elimination. One operator handles six or more machines and each machine handles 10 or more operations without changing the position of the work.

Why not look forward to greater things in 1916 and get in touch with the automatic way of handling your work?

Send us prints of your parts and we'll gladly furnish a complete report covering the cost of doing it automatically.

OFFICES AND REPRESENTATIVES: Office for Great Britain and France, 68 Avenue de la Grand Armee, Paris, J. Ryan, Manager. New York Office: Fulton Bldg., 50 Church St., Walter H. Foster, Manager. Detroit Office: Modern Machinery & Engineering Co., 1514 Ford Bldg. Chicago Office: 4213 Sheridan Road, Chas. H. Shaw, Manager. Toronto Office: 1501 Royal Bank Bldg., E. C. Roelofson, Manager.

FOREIGN AGENTS: Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne, England and Glasgow, Scotland. Alfred H. Schutte, Cologne, Brussels, Barcelona, Bilbao. Schuchardt & Schutte, Berlin, Vienna, Stockholm, Petrograd, Copenhagen and Budapest.

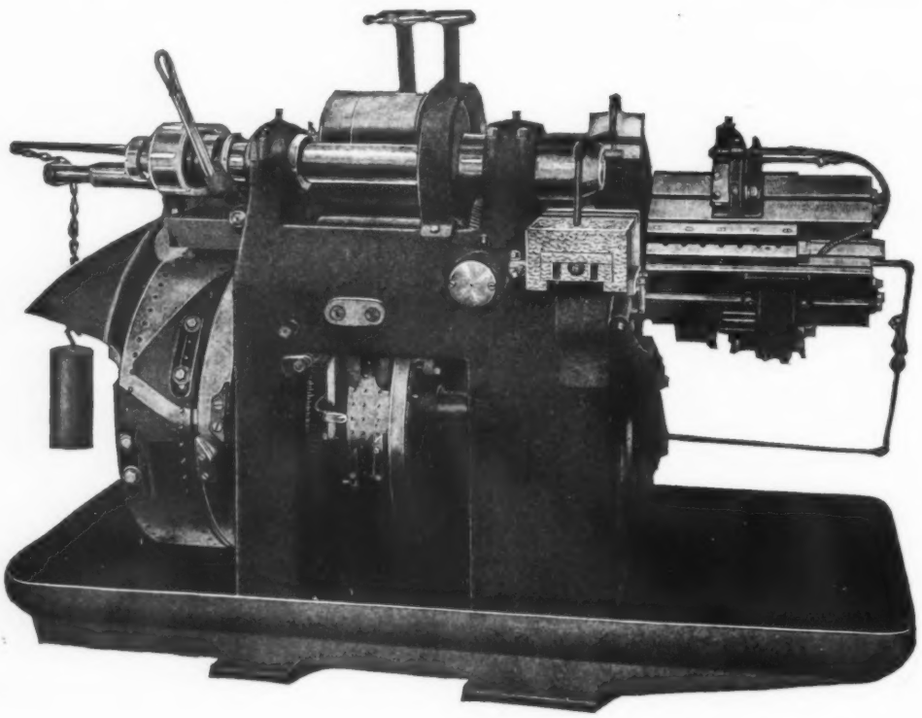
Accuracy—
On An Automatic

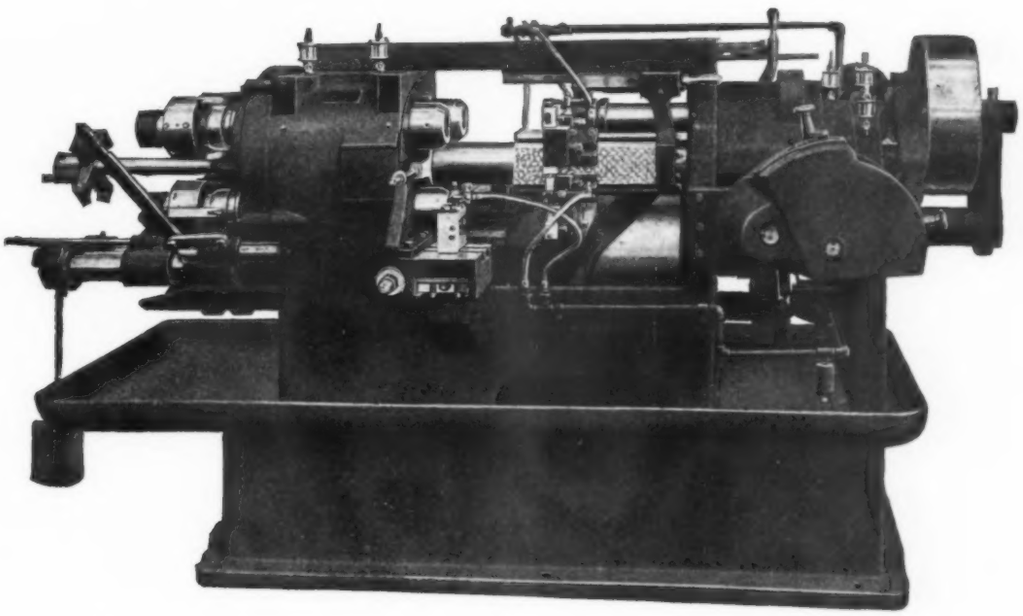
There's one big feature of Gridley Automatics that stands out boldly. It is their accuracy.

Accuracy comes through perfect alignment between spindles and tool slides. Note the Gridley construction.

With the **Single-Spindle Machine** the axis of the turret is parallel with the spindle, and permits us to make a turret practically as long as the bed of the machine itself with a bearing at each end.

GRIDLEY





AUTOMATICS

With the **Multiple-Spindle Machine,** the spindle carrier has an extension which reaches to the other end of the machine with a bearing at this outer end. Onto this extension is mounted the tool-slide.

With this construction there are no adjustments necessary to maintain alignment, and with continued use there will be no difference as regards accuracy of the work. The tool-slide, being mounted on the spindle carrier, will always be in perfect alignment with it.

Gridley Automatics are not only accurate when new. They maintain their accuracy after long periods of the severest service. Consider this point.

Multiple-Spindle Automatics

Single-Spindle Automatics

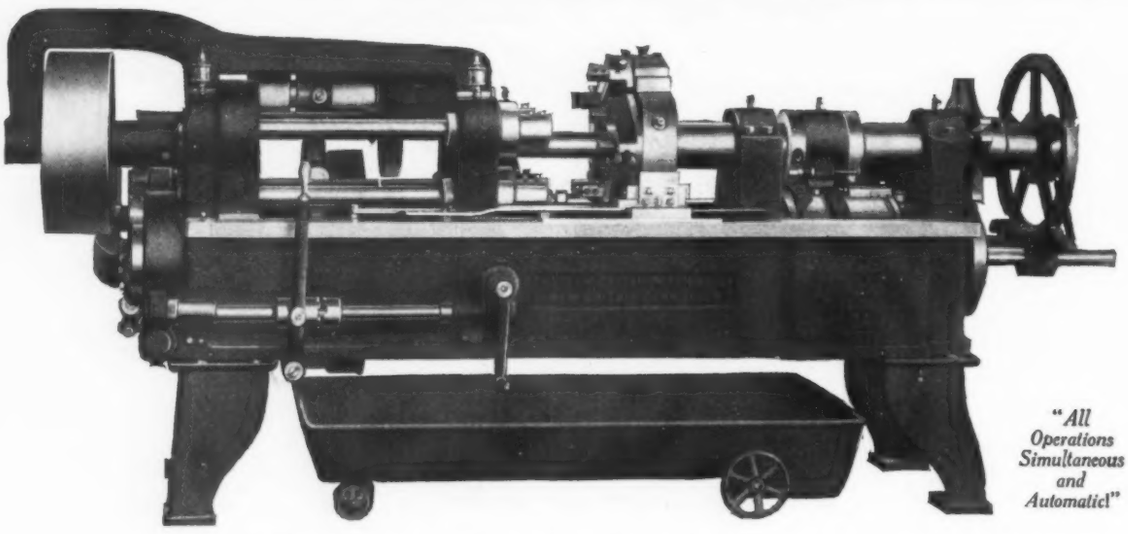
Windsor Machine Co., Windsor, Vt., U. S. A.

AGENTS AND REPRESENTATIVES: Western Sales Office, 4213 Sheridan Road, Chicago, Ill. Windsor Machine Company, 68 Avenue de la Grand Armee, Paris, J. Ryan, Manager, for Great Britain, France, Belgium and Switzerland.

FOREIGN AGENTS: CRAVEN BROTHERS, LTD., Manchester, England, Great Britain and Colonies. CHARLES CHURCHILL & CO., London, Birmingham, Manchester and Newcastle-on-Tyne, England and Glasgow, Scotland. M. KOYEMANN, Charlottenstrasse, 112, Dusseldorf, Germany, Austria-Hungary, Italy, Switzerland. SHIMUNEK & CO., Moscow, Russia. F. G. KRETSCHMER & CO., Frankfort-on-Main, Germany, for Balkan States.

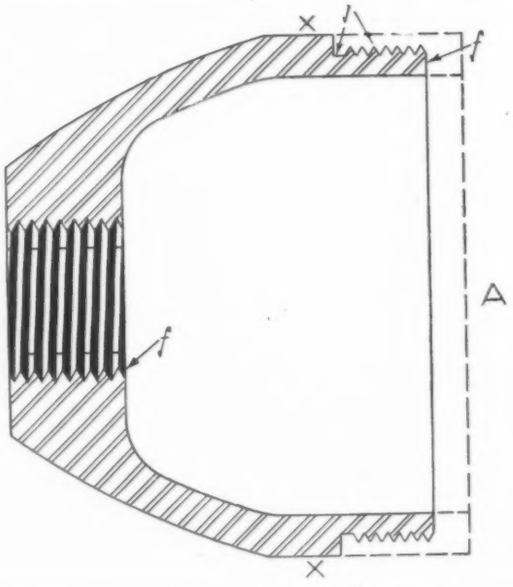
SHRAPNEL PARTS?

NEW BRITAIN AUTOMATICS!



"All Operations Simultaneous and Automatic!"

48 Shrapnel Shell Heads Per Hour!



Labor Cost:
62½ Cents Per 100

This Steel Shrapnel Head is finished as indicated *at one setting* in Size 24 Automatic Four-Spindle Single-Head Chucking Machine.

Outline of rough forging is indicated by dotted line on drawing.

Material:
Steel Forging

Operations:

Faced — Chamfered — Turned — Bored — Undercut — Tapped and Threaded *simultaneously*—while gripped in chuck at X-X.

SINGLE-HEAD MACHINE IN FOUR SIZES

If a "New Britain" would handle more or less of your chuck work at ***one-half*** *to* ***one-fifth*** *of what it is now costing you—wouldn't you like to know it? We will gladly go over samples or blue-prints of your particular work and give you* ***guaranteed*** *estimates of "New Britain" production thereon.*

DOUBLE-HEAD MACHINE IN THREE SIZES

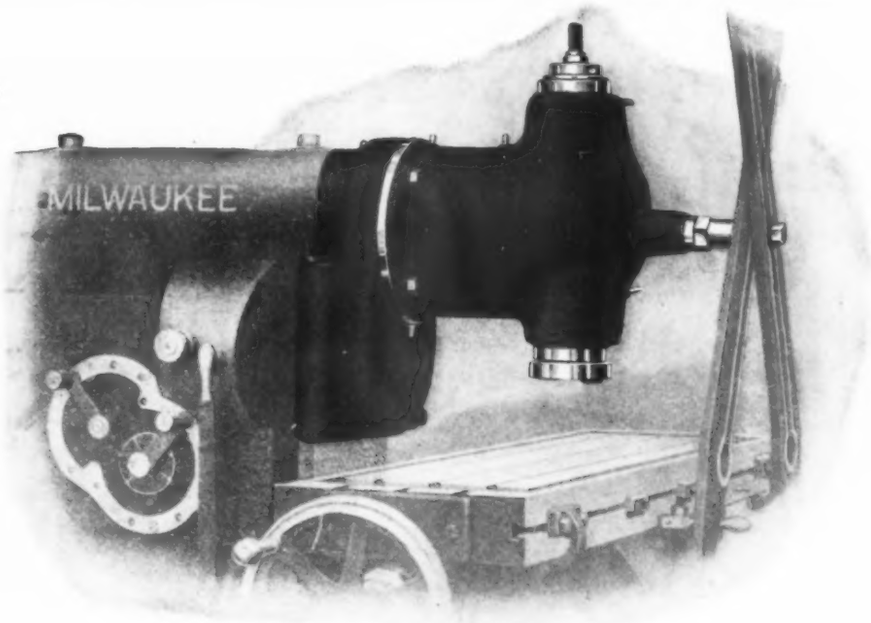
The New Britain Machine Co.

—Automatic Screw and Chucking Machines—

New Britain, Conn., U. S. A.

SALES OFFICES:
2008 W. Grand Boulevard, Detroit, Mich.
949 Otis Bldg., Chicago, Ill.

FOREIGN AGENTS:—Alfred H. Schutte, Cologne and Berlin. Coats Machine Tool Co., Ltd., Caxton House, London. Donauwerk Brust Krause & Co., Wein, Prague and Budapest.



The vertical spindle attachment for Horizontal Milwaukee Millers

The chief purpose of a vertical spindle attachment is to increase the range of work and the flexibility of a horizontal milling machine. To fulfill this purpose most completely, it must be properly designed to form a rigid and effective unit with the machine.

The vertical spindle attachment for Milwaukee Millers is designed to secure extreme rigidity. It takes the same capacity of work as the main spindle and all tools interchange between the main spindle and the spindle of the vertical attachment.

In a few minutes a Milwaukee horizontal miller can be changed to a vertical machine (or vice versa) and will be equally efficient as either. This is especially advantageous in shops where the amount of work does not warrant installing both vertical and horizontal millers or where it is more desirable to have one very flexible miller rather than two separate machines.

An attachment clamped to the main column as we clamp attachments on Milwaukee Millers becomes practically an integral part of the machine. The dovetail of the knee slide is carried up past the end of the spindle to the overarm. The base casting fits snugly over this dovetail and is securely fastened by means of a heavy gib.

The drive is accomplished through a spur gear, attached to the face of the horizontal spindle, driving a second spur gear directly above. In this manner the nose of the vertical spindle is brought directly in line with the center of the horizontal spindle so that practically the same work can be taken under the vertical spindle as can be taken under the horizontal spindle. The gears are of hardened steel. The vertical spindle runs in bronze bearings that are provided with adjustment for wear in exactly the same manner as the horizontal spindle bearings.

The spindle head has a circular base and is bolted to a base casting having a circular T-slot. This swiveling joint has a bearing about equal to the full width of the column. This construction permits the spindle head to be set at any point in a complete circle.

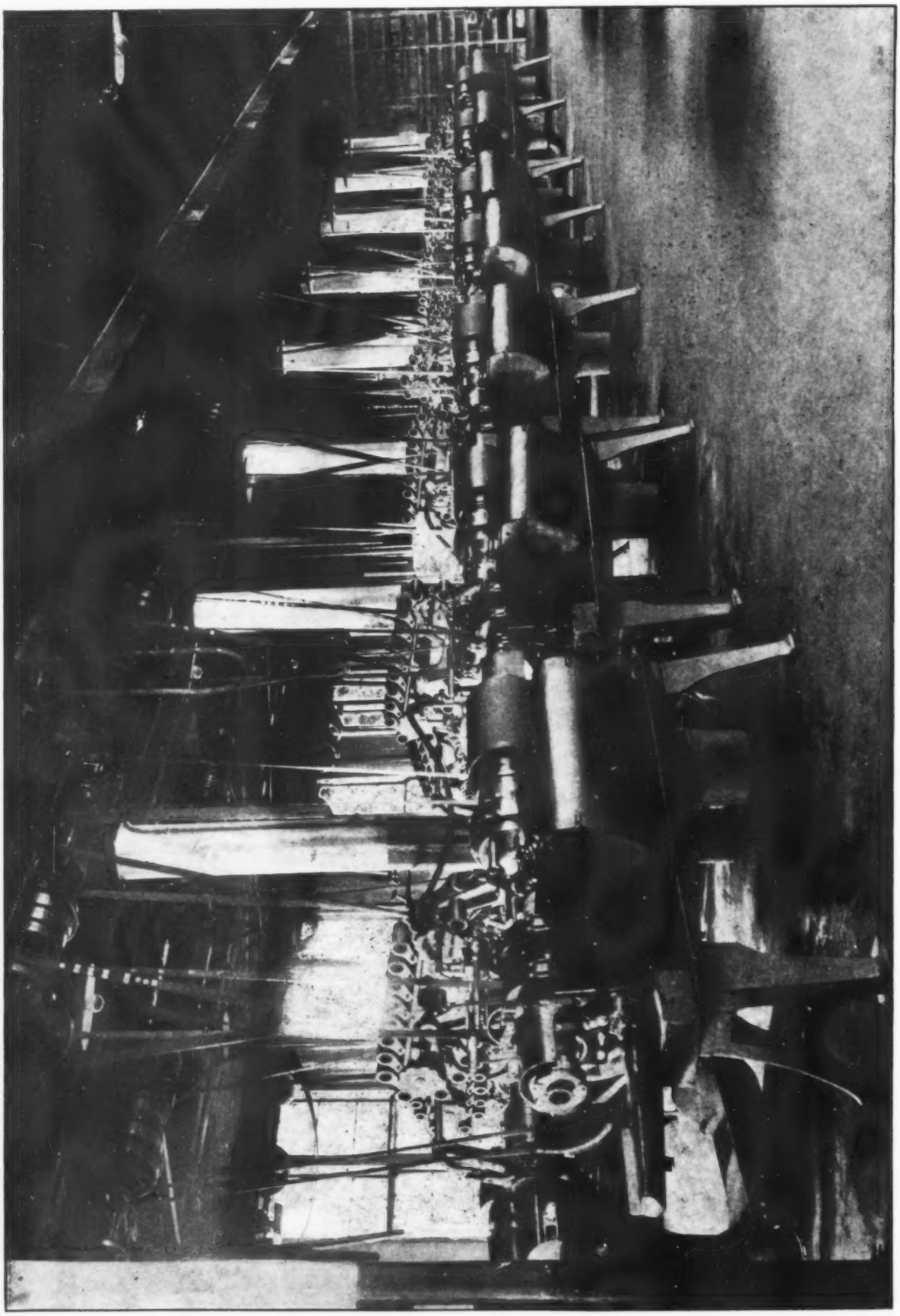
This last point is important because there are many operations possible with the cutter set at an angle that could not be performed if the spindle were rigidly set in a vertical position. For instance, to mill pieces with a concave form, the cutter may be set at an angle and fed longitudinally. This would do away with the need for a special formed cutter for such a job.

The vertical spindle attachment is also found useful in cases where a face mill, because of the superior finish it gives, is preferable to a slab mill.

By using the spindle attachment in conjunction with the rotary table, continuous milling operations can be performed on a horizontal machine.

Complete information concerning Milwaukee Millers and attachments is contained in our Catalogue No. 19, and you should have a copy. Write today.

KEARNEY & TRECKER COMPANY, MILWAUKEE, WIS.



Rotary Tilting Magazine

We are showing, in this ad a number of our machines with our Rotary Tilting Magazine and the object of this is to get into your mind the fact that we receive orders for our machines with this Magazine for from one to one hundred in an order.

This magazine is the simplest piece of mechanism imaginable. In many cases where you have castings which require an operation on one or both ends, or a piece made from the bar which requires a second operation, by using this magazine of ours (and one man can operate at least four machines) you minimize the cost in the extreme and this is what we are all interested in.

To change from one job to another takes but a very short time. In many instances we lower the cost of production from 100% to 500%. Figures as true as they are interesting.

The machines shown here are fitted with an air chuck so that the variation in the ordinary casting makes no particular difference; all grip the piece at a certain pressure constantly.

It would be worth your most serious consideration to remember us because we are in this business of magazining parts in our machines to a greater extent than any other manufacturer of automatics in this country. Kindly remember this.

Cleveland Automatic Machine Company

Cleveland, Ohio, U. S. A.

"Cleveland"

You Want Oil in the Bearings But Not on the Belts

The oil-pan under the pulley bracket prevents surplus oil from the cam and belt-shifter studs from dropping on the belts and pulleys.

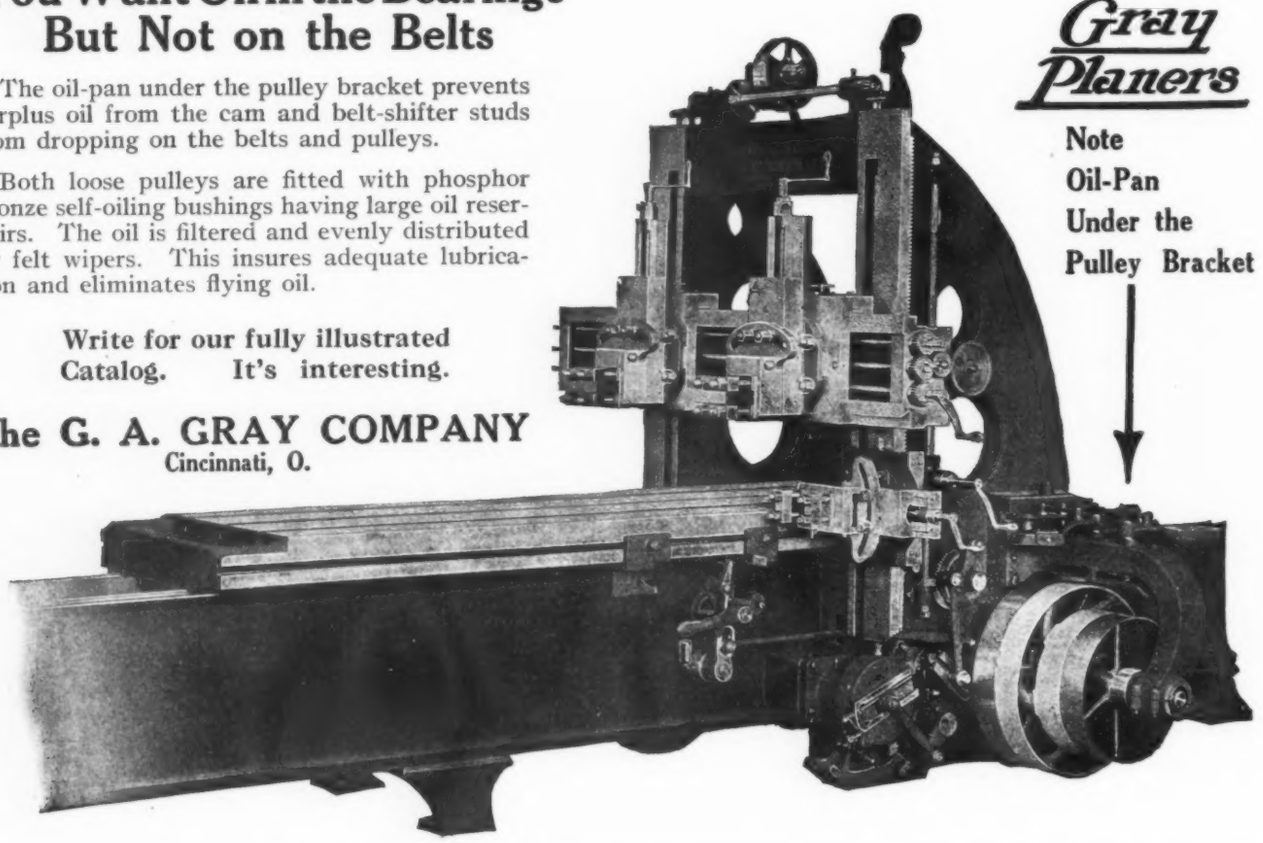
Both loose pulleys are fitted with phosphor bronze self-oiling bushings having large oil reservoirs. The oil is filtered and evenly distributed by felt wipers. This insures adequate lubrication and eliminates flying oil.

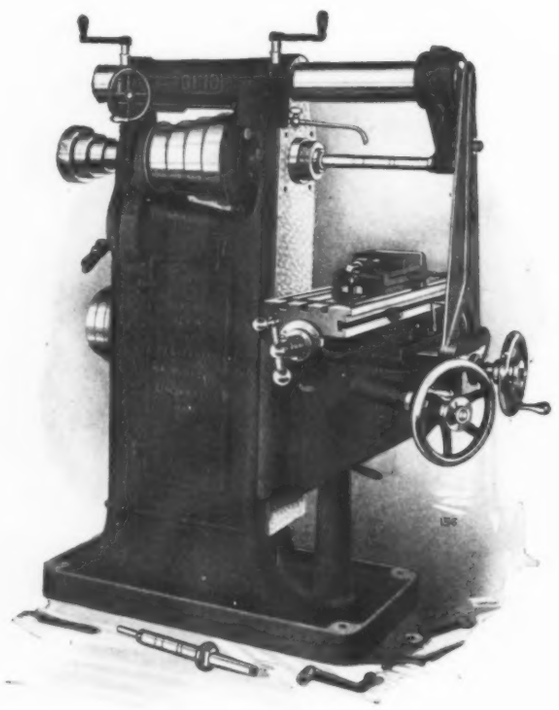
Write for our fully illustrated Catalog. It's interesting.

The G. A. GRAY COMPANY
Cincinnati, O.

Gray Planers

Note Oil-Pan Under the Pulley Bracket





20% increase in belt velocity means 20% greater production. This is what you get with our large cone and positive drive arbor. Low cost because investment includes inexpensive cone feed, instead of quick feed change gear mechanism—a design not necessary on so small a machine. 4 different ranges each, plain and universal, constitute the obtainable sizes.

Write for more detailed information.

The Oesterlein Machine Co.

Manufacturers of

Millers Cincinnati, **OHIO** **Grinders** U. S. A.

The Bearing That Lengthens Your Machine's Life

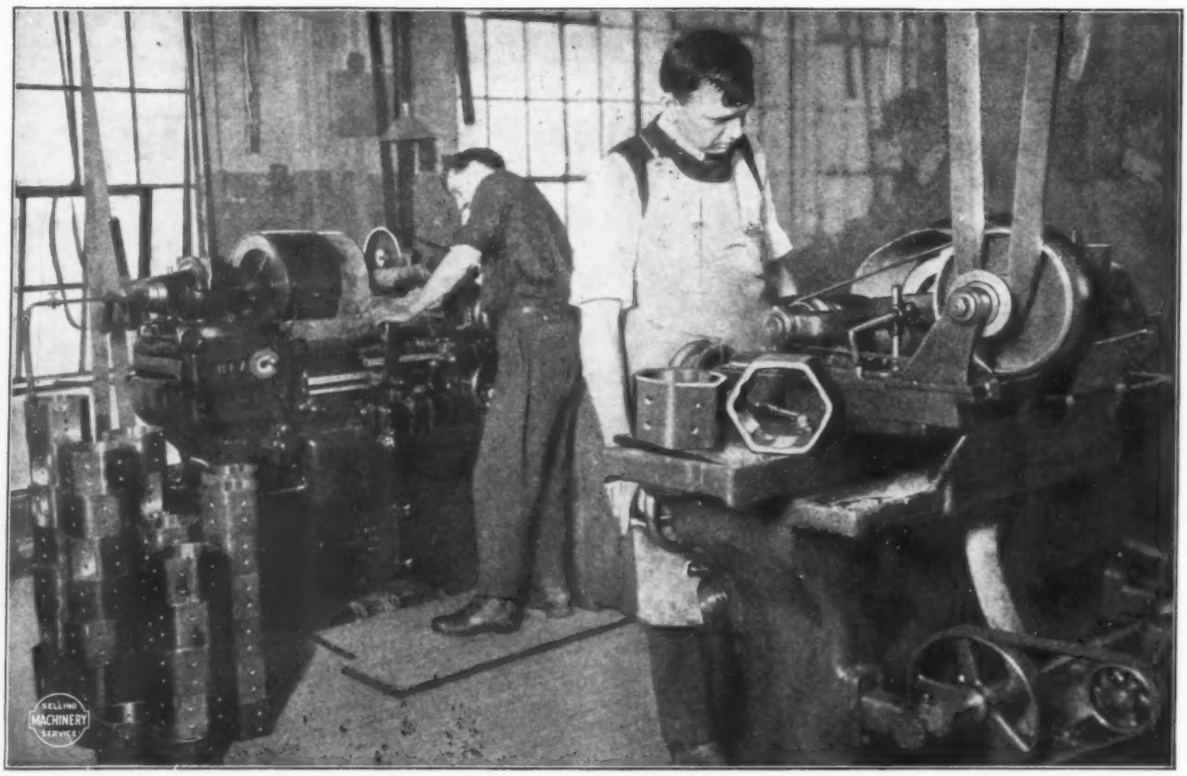
No one element of a machine's endurance is more important than its bearings. Good bearings make a good machine better. That's why builders of good machines equip with HESS-BRIGHTS.

Hess-Bright's Conrad Patents are Thoroughly Adjudicated

The Hess-Bright Manufacturing Company
Philadelphia

HESS-BRIGHT

The Inimitable Bearing



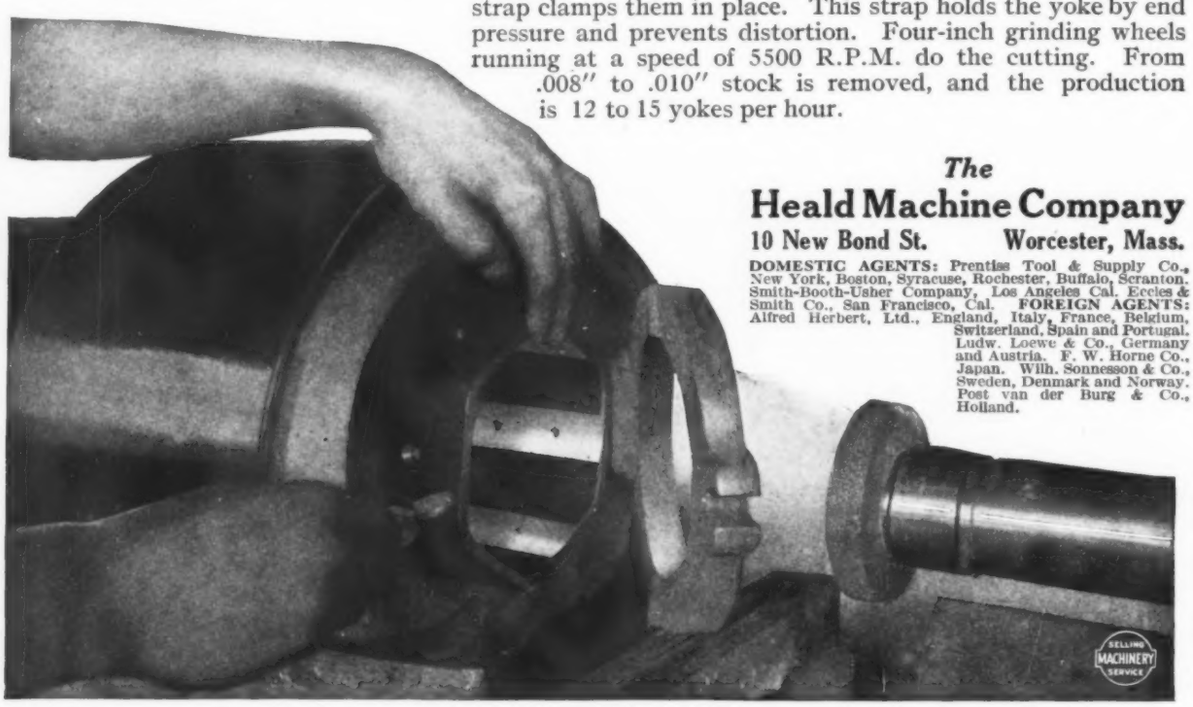
The HEALD

Internal Grinding Machines—And An Example of Good Production

The yokes for single unit electric starters made by the Simms Magneto Company, East Orange, N. J., are of low carbon steel, made in two halves and welded together. Then the seats for the six poles are rough-bored and finished by grinding on Heald Internal Grinders.

The diameter of the ground surface is $5\frac{1}{2}''$ and its length $4\frac{1}{2}''$. A limit of 0.0005″ is maintained.

See how simply the yokes are held on the spindle. Just one strap clamps them in place. This strap holds the yoke by end pressure and prevents distortion. Four-inch grinding wheels running at a speed of 5500 R.P.M. do the cutting. From .008″ to .010″ stock is removed, and the production is 12 to 15 yokes per hour.



The

Heald Machine Company

10 New Bond St. Worcester, Mass.

DOMESTIC AGENTS: Prentiss Tool & Supply Co., New York, Boston, Syracuse, Rochester, Buffalo, Scranton. Smith-Booth-Usher Company, Los Angeles Cal. Eccles & Smith Co., San Francisco, Cal. **FOREIGN AGENTS:** Alfred Herbert, Ltd., England, Italy, France, Belgium, Switzerland, Spain and Portugal. Ludw. Loewe & Co., Germany and Austria. F. W. Horne Co., Japan. Wilh. Sonnesson & Co., Sweden, Denmark and Norway. Post van der Burg & Co., Holland.

plus: 2 shops 195 tool makers

The acquisition of two nearby shops puts us in an enviable position in these rushing times.

For now we are really able to give you

QUICK SERVICE

in designing and manufacturing any tools that you may desire,

JIGS, FIXTURES and GAUGES

of any kind at all.

To an equipment which was already large the acquisition of these two shops has added much bigger and better facilities.

Besides, 195 experienced toolmakers employed by these shops are ready to serve you.

Submit us drawing and sample of part to be machined showing operation to be performed and we'll furnish you with the tools. Or we'll manufacture fixtures from your own drawings.

Work done on an hourly basis or at a contract price and backed by the "Becker" guarantee.

Send us your requirements TODAY

Prompt Service Assured.

Becker Milling Machine Co.

Hyde Park, Boston, Mass.

Consider the features of the

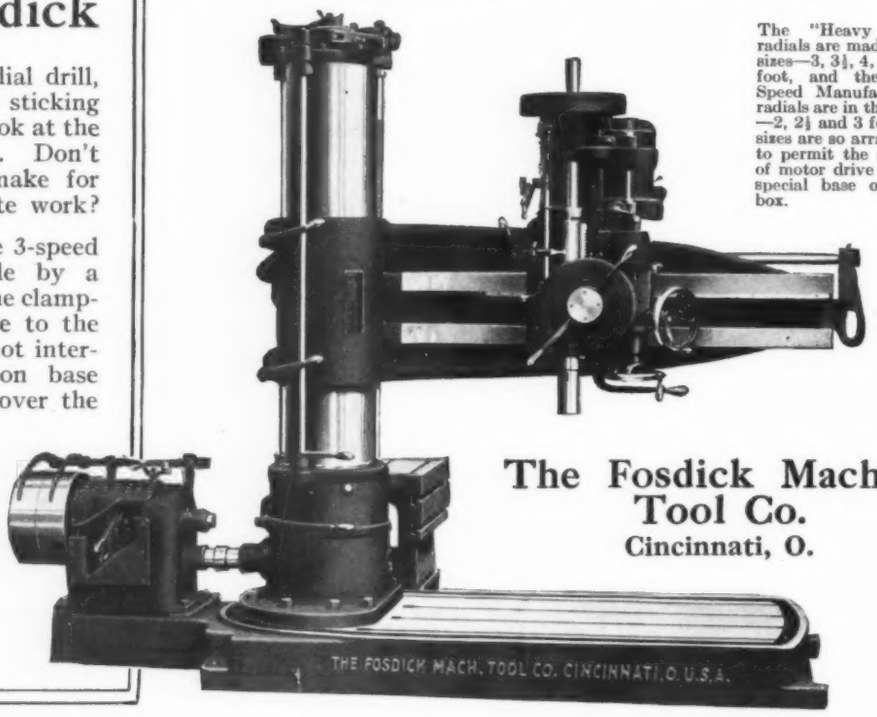
4 ft. Fosdick

A heavy duty radial drill, with convenience sticking out all over it. Look at the operating handles. Don't you think they make for quick and accurate work?

Look further: The 3-speed changes are made by a single lever, and the clamping lever lies close to the column. It will not interfere with work on base when the arm is over the table. And note this well — the elevating handle cannot be accidentally engaged.

The full story is contained in the catalog. Send for your copy *today*.

Could the handles be placed more conveniently?

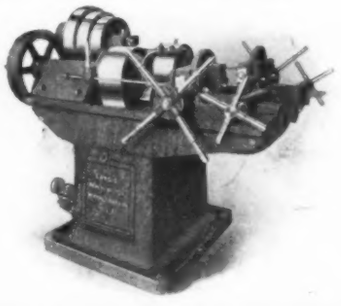


The "Heavy Duty" radials are made in five sizes—3, 3½, 4, 5, and 6 foot, and the "High Speed Manufacturing" radials are in three sizes —2, 2½ and 3 foot. All sizes are so arranged as to permit the addition of motor drive without special base or speed box.

The Fosdick Machine Tool Co.
Cincinnati, O.

Use Landis Dies and Snap Your Fingers at the Present High Cost of High Speed Steel

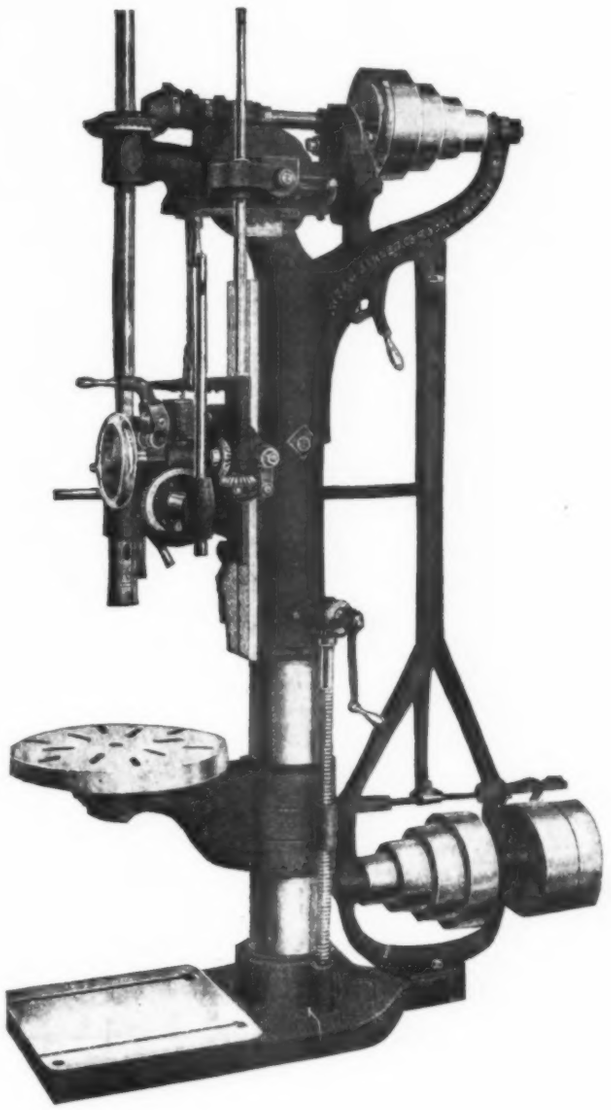
Don't be at the mercy of the prevailing prices of high speed steel. You can cut out this worry, as far as your dies are concerned, by using **Landis Dies** instead of hobbed dies. Both use the same amount of high speed steel, but the **Landis** has a life from 10 to 20 times longer than the hobbed type. Naturally this means fewer dies to be bought; an item worth appreciating in the face of the present high prices of high speed steel.



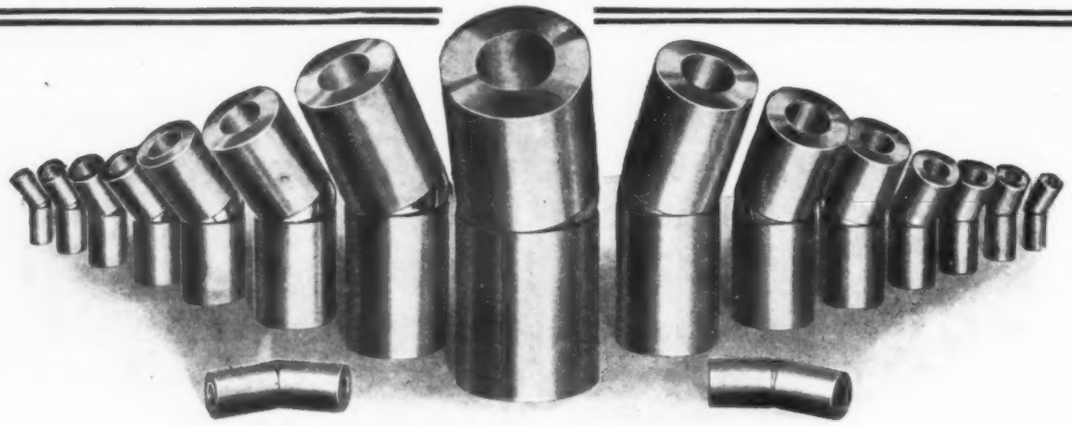
Also consider the interchangeability of the Landis Die Chasers, which means that any one or more of a set can be replaced without renewing the entire die. The same set of Landis Dies may be used for both right- and left-hand threading. **Write for Catalog No. 22.**

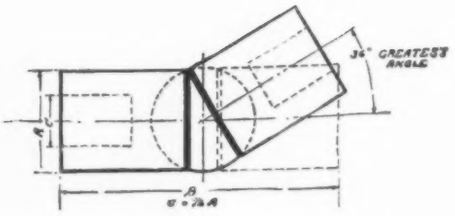
Landis Machine Company
Waynesboro, Pa., U. S. A.

TRADE
W.F. AND J.B.
MARK



BARNES DRILLS





SPECIFICATIONS

A	$\frac{5}{8}$"	$\frac{3}{4}$"	$\frac{7}{8}$"	1"	$1\frac{1}{4}$"	$1\frac{1}{2}$"	$1\frac{3}{4}$"	2"	$2\frac{1}{2}$"	3"	4"
B	$2\frac{1}{4}$"	$2\frac{11}{16}$"	$3\frac{1}{4}$"	$3\frac{1}{2}$"	$3\frac{3}{4}$"	$4\frac{1}{4}$"	$4\frac{1}{2}$"	$5\frac{7}{16}$"	7"	9"	10
	$2.50	2.50	3.15	3.15	3.75	4.10	4.70	5.65	9.40	32.00	75.00

Patents, Nos. 785,839 and 801,934. Others Pending.

Universal Joints

for All Transmission Having Shaft Deflection

Wherever shaft deflection is essential—specify Baush Universal Joints; especially for main drive (pump drive) magneto drive—starting device on automobile construction.

With Baush Universal Joints you can run things straight or all out of kilter and the power will be transmitted as readily and with the same degree of efficiency as is possible with rigid shaft.

Get next to the possibilities of the Baush Universal Joint. Note its construction. Specify it as equipment for your machines.

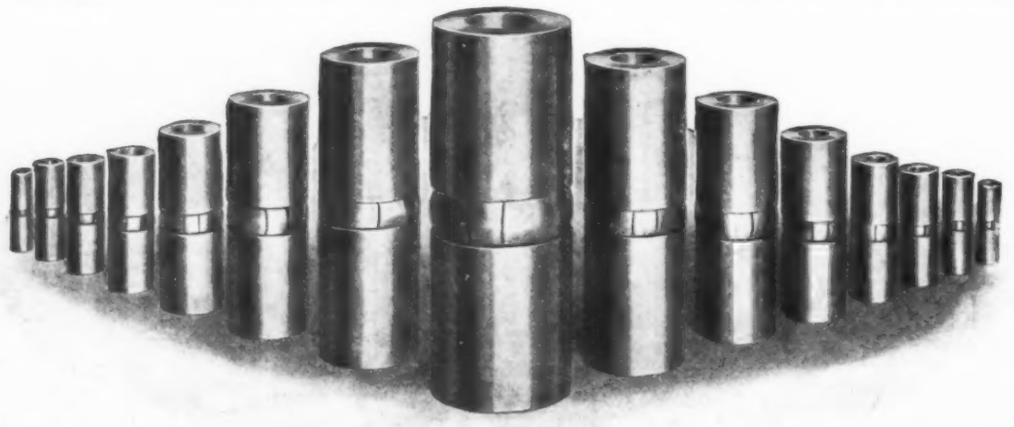
MANUFACTURED BY

THE BAUSH MACHINE TOOL CO.

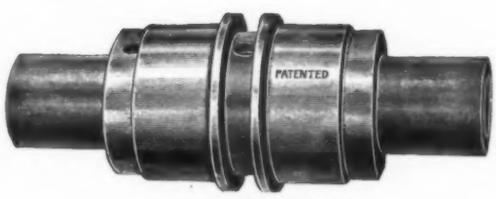
SPRINGFIELD, MASS, U. S. A.

Builders of

RADIAL DRILLS — MULTIPLE SPINDLE DRILLS — UPRIGHT AND HORIZONTAL

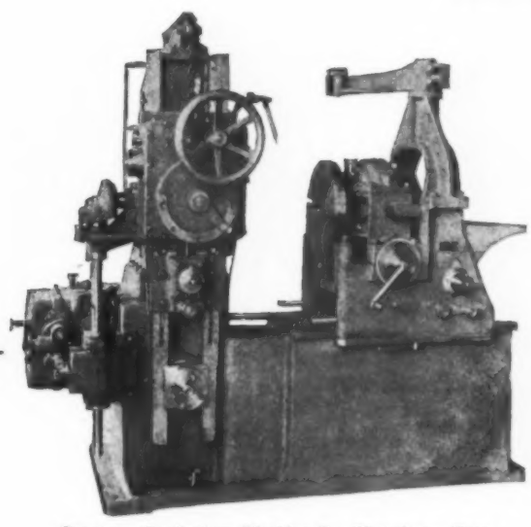


The Johnson Friction Clutch Is Being Used As A Part Of This Machine



Double Clutch—Exterior.

Right Here →



Courtesy: Rowbottom Machine Co., Waterbury, Conn.

The Rowbottom Universal Cam Milling Machine

The Johnson Friction Clutch is incorporated in the gear box of the Rowbottom Universal Milling Machine to start and stop the machines and to allow instant control regardless of countershaft shipper.

Johnson Friction Clutches are in line with the general high quality of the mechanical perfection so distinctive of this machine.

The following quotation from a customer's letter is an example or the general satisfaction of all users.

"We have now three of these machines in constant operation at our own factory and are cutting all kinds and styles of cams within the capacity of the machine. We have had much success in this line and can guarantee very accurate work."

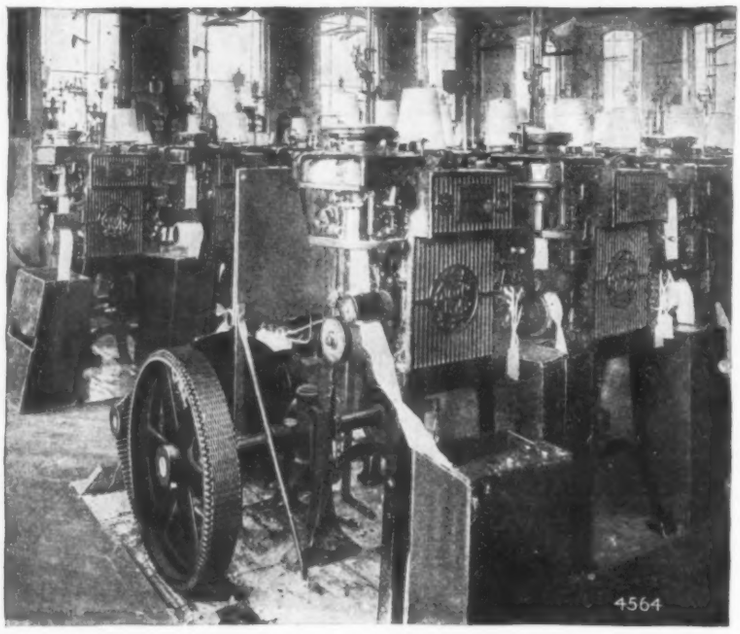
Write for Blue Catalog and our latest free booklet, "Clutches as Applied in Machine Building."

THE CARLYLE JOHNSON MACHINE CO.
MANCHESTER, CONN.

England: The Efandem Co., Ltd., 159/165 Great Portland St., London, W. Sole Agents for British Isles.

LINK-BELT SILENT CHAIN

For the *Efficient* Transmission of Power



5-H.P. Link-Belt Silent Chain Drive operating line of Knitting Machines.
Note the compactness of the Drive (casing over drive removed for photographing)

ONE of the most important things to be considered in a modern mill, shop, or factory is the method of transmitting power to the various mach nes, because the efficiency of these machines, the quality of the product and the economy, in power-consumption depend largely upon the character of the drive.

Until recent years it was considered good practice to transmit power by means of leather belts and spur gears, but with the more general use of electric motors came the modern high-speed Link-Belt Silent Chain Drive, and its merit as a power-transmitter is winning constantly-increasing recognition.

While its field of application to motor-driven machinery is almost universal, Link-Belt Silent Chain is particularly suited to driving textile and similar machinery, because it gives a smooth, positive and steady drive, without the noise and shock of gears and without the slip and consequent loss of power of leather belts.

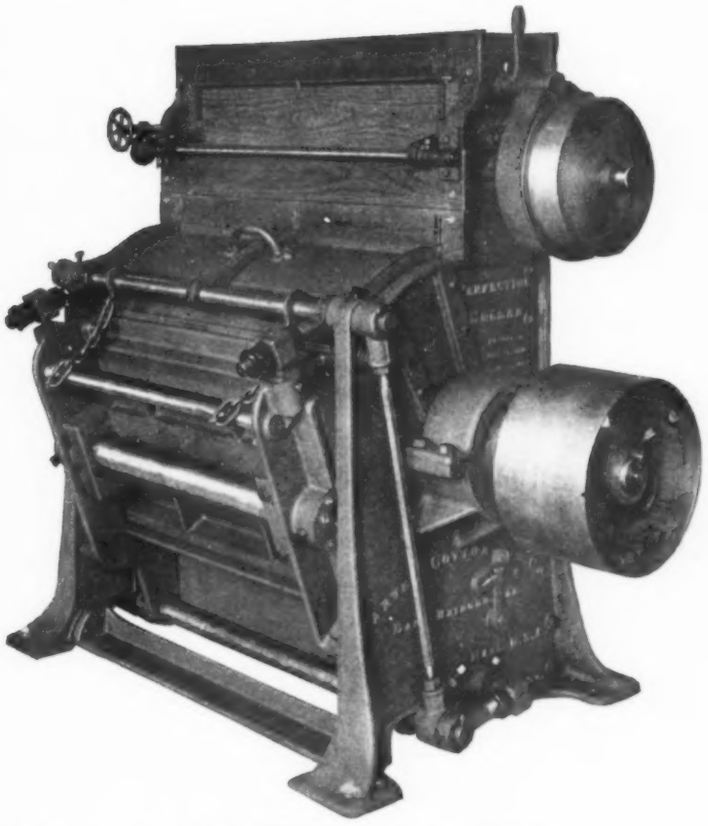
Catalog containing full particulars sent on request.

One way to distinguish Link-Belt Silent Chain—
Look for the name on the washers;
Look for the liners in the joints.

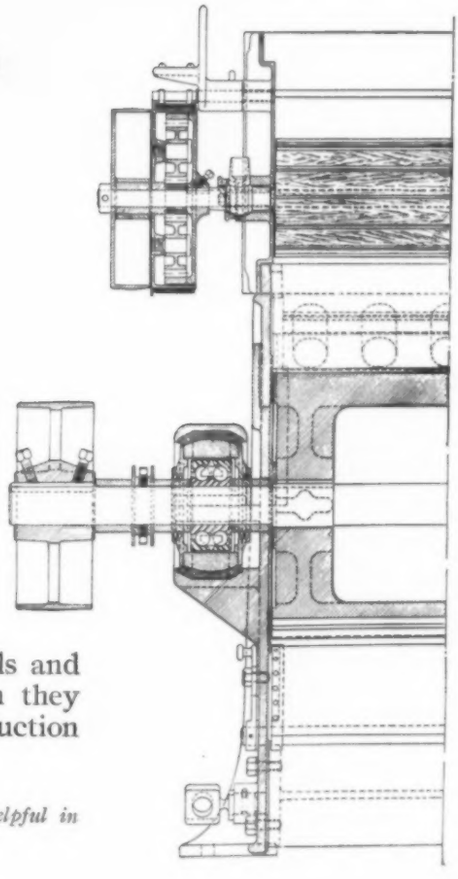
LINK-BELT COMPANY

Philadelphia **Chicago** **Indianapolis**

New York.....299 Broadway
Pittsburgh.....1501 Park Building
Boston.....49 Federal St.
St. Louis.....Central National Bank Building
Buffalo.....698 Ellicott Square
Wilkes-Barre.....2nd National Bank Building
Detroit.....732 Dime Bank Bldg.
Cleveland.....1304 Rockefeller Building
Seattle.....580 First Ave., South
Portland, Ore.....14th and Lovejoy Sts.
Los Angeles.....204 N. Los Angeles St.
Knoxville.....D. T. Blakey, Empire Bldg.
Denver.....Lindrooth, Shubart & Co.
Minneapolis.....418 So. Third St.
New Orleans...Whitney Supply Co., 418 So. Peters St.
San Francisco..Meese & Gottfried Co., 660 Mission St.
Birmingham.....General Machinery Co.
1546 Brown-Marx Bldg.
Montreal, Can.....John Millen & Son, Ltd.
Toronto, Can.....Canadian Link-Belt Co., Ltd
Louisville.....Frederick Wehle, Starks Bldg.



The main driving shaft of the "Perfection" Cotton Huller runs on two



NEW DEPARTURE BALL BEARINGS

American Made for American Trade

***of the* DOUBLE ROW TYPE**

They insure at all times a perfect and permanent alignment of every working part of the machine.

These "fool proof" units carry *all* the loads and stresses simultaneously from *whatever* direction they may come, with equal efficiency and with a reduction of friction to the vanishing point.

It may be that our Mechanical Research Department might be helpful in solving some of your bearing problems. Send for literature.

The New Departure Manufacturing Company

Bristol, Conn., U. S. A.

Conrad Patent Licensee

Western Branch: 1016-17 Ford Building, Detroit, Michigan

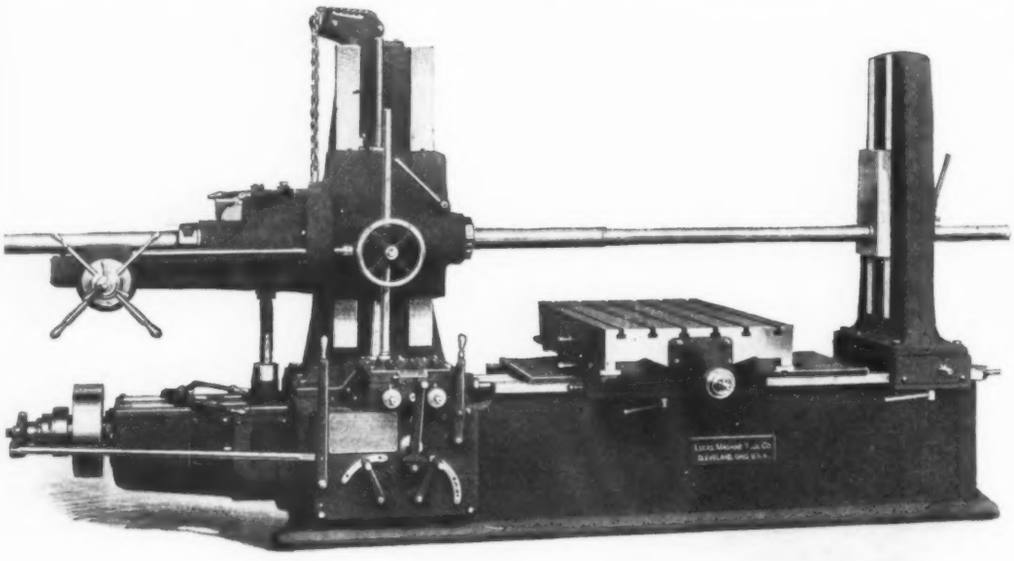
Distributors in Trade Centers throughout the United States.

For Continent of Europe: Jacob Holst, Copenhagen, Freeport, Denmark.

Sole British Agents: Brown Brothers, Ltd., London and Manchester.

"To make good is to have your work yield beneficial results." The

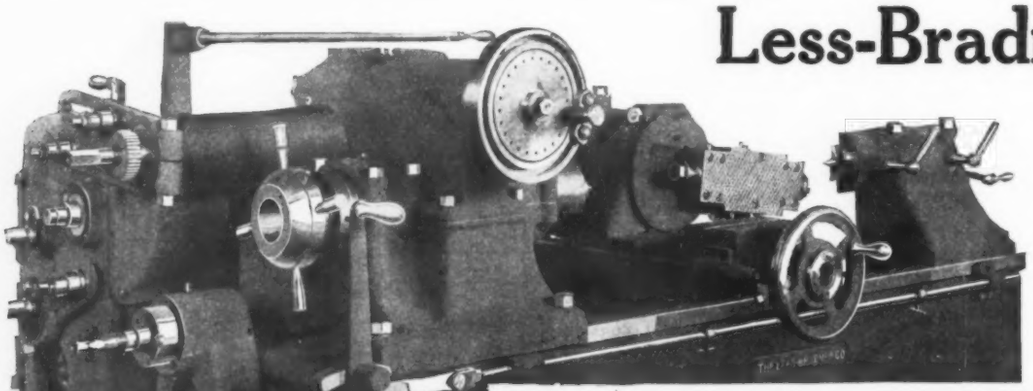
"PRECISION" BORING, DRILLING and MILLING MACHINE

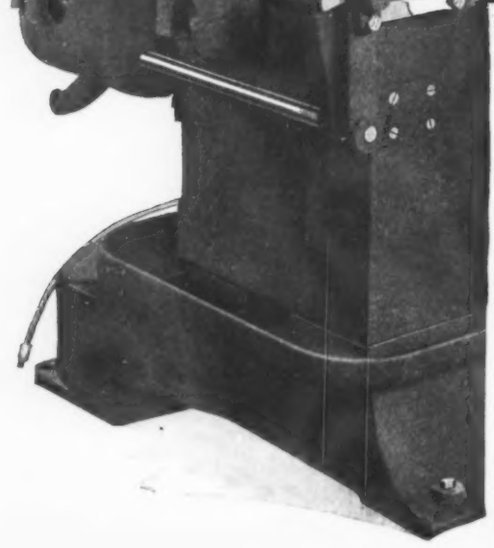


Makes Good
Give Your Money
a chance to
Make Good
by putting it into a "PRECISION"

Lucas Machine Tool Co. NOW AND ALWAYS OF Cleveland, Ohio, U. S. A.

Less-Bradner





THREAD MILLING MACHINES
For
ALL PURPOSES

The Lees-Bradner Company
Cleveland, Ohio, U. S. A.

Buy Oil—Add Water

Cutting Compounds are 30% to 60% Water

Estimating the average cost of barreling, hauling and freight on each barrel of cutting compound at $6.00, this means that every user of cutting compounds pays $2.00 to $4.00 per barrel for barreling and transporting *water.*

You save this waste when you buy

Solcut

Solcut is a concentrated oil that readily dissolves in pure water. You buy a barrel of **Solcut** and add 10 to 50 barrels of water to make a cutting mixture of any desired consistency.

On automatic machines, 1 part **Solcut** to 15 parts water is used for threading or tapping and machine work, while 1 part **Solcut** to 20 parts water is used for machine work only. All work comes away from the machine with a smoother finish than with oil. The tools stand up just as well, in many cases better than with oil, and the **Solcut** mixture does not affect the bearings, after four years' use.

On giant cutting-off machines, a cut of 11-inch round crucible steel, 50 point carbon is made in 5.6 minutes, using a mixture of 1 part **Solcut** to 25 parts water. For punching 1 part **Solcut** to 40 parts water is used. For grinding, 50 parts water to 1 part **Solcut** is used.

→ FULL PARTICULARS, PRICES AND LIST OF USERS IN YOUR LINE GLADLY FURNISHED ←

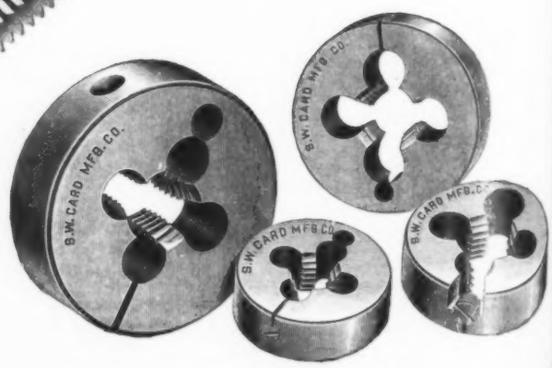
E. F. HOUGHTON & CO.

Third and Somerset Streets **Philadelphia, U. S. A**

New York	Syracuse	Trenton	Cleveland	Chicago
Boston	Buffalo	Baltimore	Cincinnati	Detroit
Hartford		Pittsburgh		St. Louis

England and Wales: Edgar Vaughan & Co., Ltd., Birmingham, England. Scotland: Jas. S. Crawford & Sons, Glasgow. Spain: La Maquinaria Anglo-Americana, Barcelona.

Here's the Real Point About TAPS and DIES



RD

Because taps and dies are well finished or cost less money, has little or no bearing unless they thread to size and lead.

If they do good threading, the further thing you want to know is: *How many holes or pieces and at what speed are you able to operate?*

The very best steel for the purpose is used in the manufacture of CARD TAPS and DIES—they will stand hard service and fast driving.

If other makes of taps and dies give you trouble, get in touch with CARD. You will have occasion to *remember* the quality and *forget* the price.

Large stock on hand of regular taps and dies in V. U. S. Standard, Whitworth and Metric (International and French Standards.)

S. W. Card Mfg. Company

Mansfield, Mass., U. S. A.

New York Store, 62 Reade Street

Berlin Store, Arthur Kayser, Mgr., Alte Jakobstrasse

EUROPEAN AGENTS—Chas. Churchill & Co., London, Birmingham, Manchester and Glasgow. Markt & Co., Ltd., Paris. Ignacz Szekely, Budapest. V. Lowener, Stockholm, Copenhagen Christiania. A. A. Kampfraath (Brussels), Ltd., Brussels. Andrews & George, Yokohama, Tokyo, Osaka. J. Lambercier & Co., Geneva. C. Civita, Milano, Italy.

This Tap is shown exact size

They'll put speed into your manufacturing—

Here are tools which are ready to lend a new impetus to rapid production—tools which owe their origin to the extraordinary conditions existing in a great many shops just now.

They are distinctly a product made to fit a need. That need is for tools better, stronger, sturdier than were thought possible a year or two ago. If this need exists in your shop, try these Taps and Reamers. They will give you a new idea of tool efficiency.

Our new Catalog No. 16 is now ready for distribution. May we mail you a copy?

Butterfield and Company

Derby Line **Vermont, U. S. A.**

N. Y. Store—62 Read St. Canada—Rock Island, Que.

You Never Saw a Threading Job

beyond the range of some Geometric Die Head.

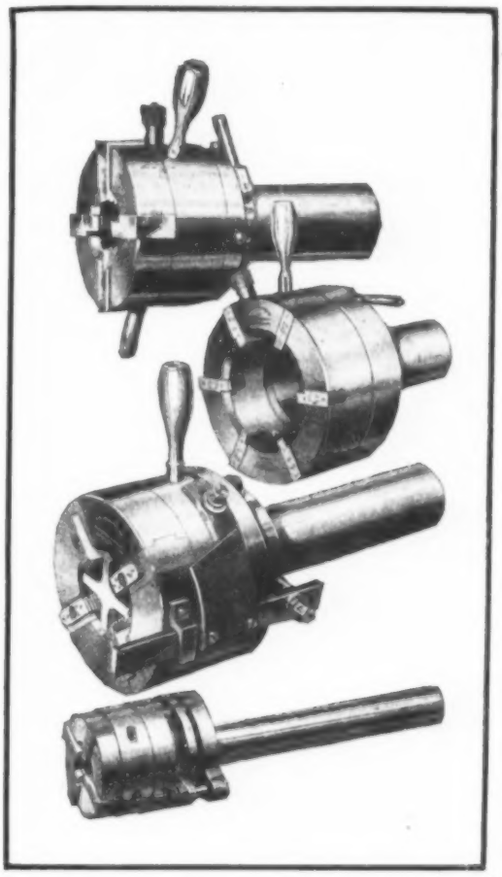
There's a Geometric Die Head for every pitch or form of thread, every diameter in reason, special threads, taper, etc.

There's a Geometric Die Head to fit any turret lathe made. And turret lathe makers throughout the United States are using this fact to their advantage.

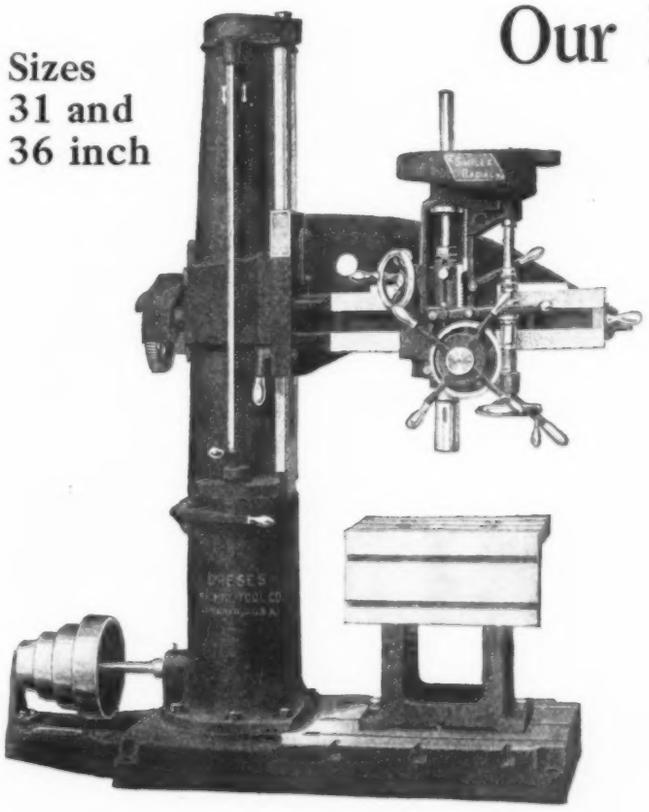
A copy of our little monthly, "Threads" is waiting for your request.

GEOMETRIC DIE-HEADS

The Geometric Tool Co.
New Haven, Conn., U. S. A.
Chicago Office, 545 W. Washington Blvd.



Sizes 31 and 36 inch



Our New Simplex Radials

are the Roustabouts in the shop

Their **price** brings a radial drill within reach of everybody who has to do drilling and tapping.

They are simple but have all features for **rapid production** and are built for the practical use of **high speed drills.**

We manufacture them in conjunction with our

Highly Developed Radials

Dreses Machine Tool Co.

Cincinnati, Ohio

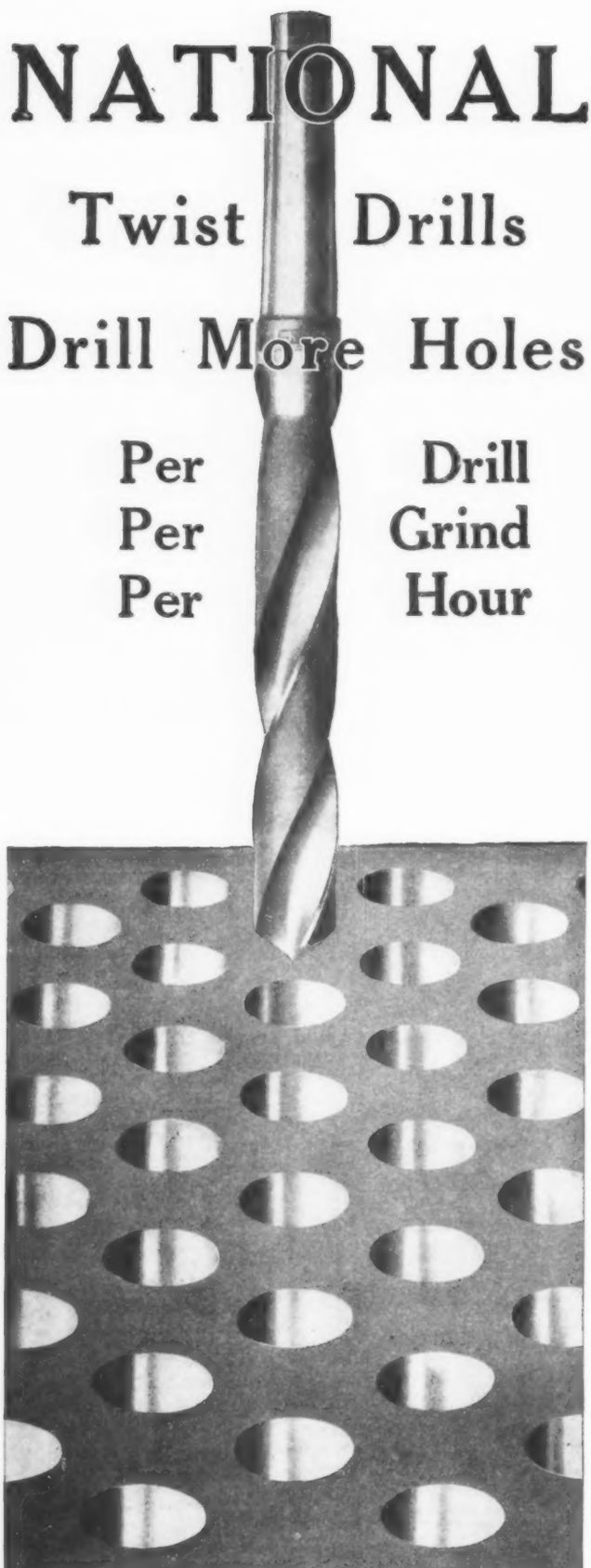
Representatives: Manning, Maxwell & Moore, New York, Boston, Philadelphia, Cleveland, Chicago, Detroit, Mexico City; Carey Machinery & Supply Co., Baltimore; Baird Machinery Co., Pittsburgh; Wm. C. Johnsons & Sons Machinery Co., St. Louis; Pacific Tool & Supply Co., San Francisco and Los Angeles; Schuchardt & Schutte, London, Berlin, Cologne, Vienna, Prague, Budapest and Stockholm, Stussi & Zweifel, Milan; R. S. Stokvis & Zonen, Rotterdam; R S. Stokvis & Fils, Paris and Brussels; Shewan Tomes & Co., Shanghai, Peking and Canton; Pacific Engineering Co., Manila.

NATIONAL

Twist Drills

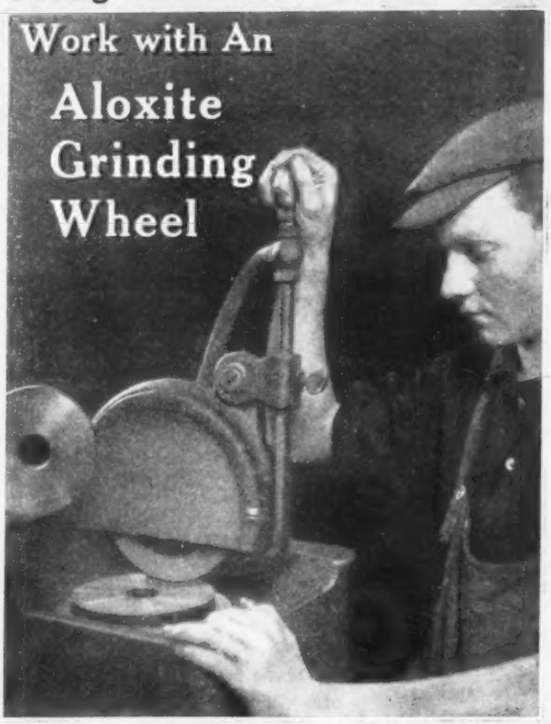
Drill More Holes

Per Drill
Per Grind
Per Hour



National Twist Drill and Tool Co.
Detroit, Michigan
104-106 So. Jefferson St., Chicago 29-33 Lafayette St., N.Y.

It's Like Putting an Old Head on Young Shoulders—to have Him



THE right wheel in the right place enables this operator to turn out accurately surfaced—perfectly finished—hardened Scottish steel collars.

The wheel is so good that he not only produces one-third more work, but better work than ever before.—With more experience the results would be even better.

The wheel lasts half again as long as others—doesn't fill—holds its grinding face.

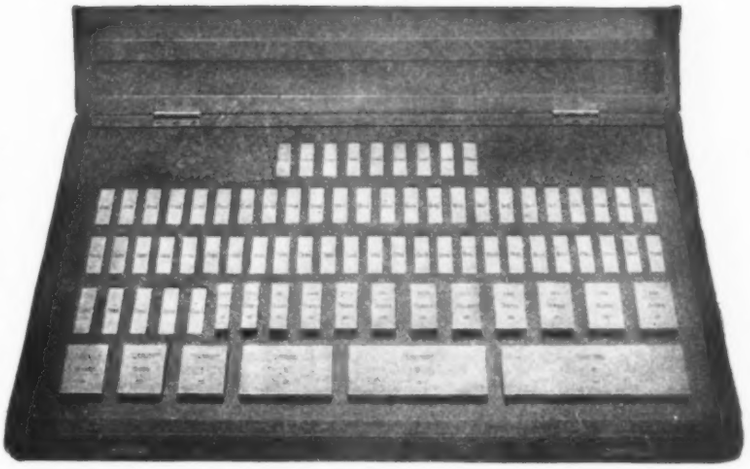
Good grinding judgment upholds the theory of having *the right wheel in the right place*—of consulting our service department.

The Carborundum Company
Niagara Falls, N. Y.

New York Chicago Boston Philadelphia
Pittsburgh Cleveland Cincinnati Milwaukee
Grand Rapids London, Eng.

Why the Limit System is being Adopted in Modern Shops

"Johansson" System No. 1



Accuracy .00001"

THE Limit System is today recognized to be the essential by all who claim to "manufacture" because it is the basis of a scientific method of producing work which is just right. It leaves nothing to chance. It not only cuts out the work which is too poor, but also that which is unnecessarily fine. Once the limits are established and maintained, each part is made as accurately as necessary, no better, no worse. In some parts the limits may be in tenths of thousandths. This is "just right"—anything coarser would not be "good enough." In other parts the limits may be in hundredths; this also is "just right"—anything finer would be "too good."

Thus the limit system facilitates the production of work which is "just right," *i. e.*, satisfactory for the use to which it is to be put, and it is the only system by which interchangeable work can be produced commercially.

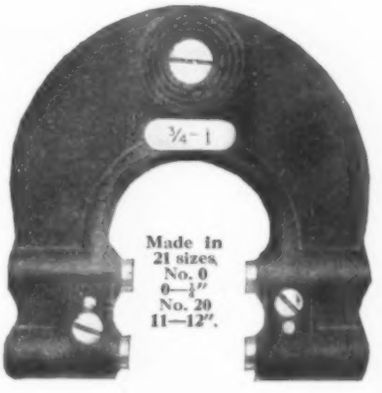
No one can, upon investigation, fail to admit that the "Johansson" Combination Standard Gages are an absolute essential to the installation and proper maintenance of a Limit System.

Johansson Adjustable Limit Snap Gage Brings the Limit System Within Everyone's Reach

The Johansson Limit Snap Gage is adjustable for wear and various sizes. It has insulated grip which not only guarantees that the gage is not distorted by the heat of the hand, but actually forces the operator to acquire that light and sensitive touch so essential in all close measuring. "Go" and "Not Go" sizes are obtained without turning the gage.

The "Johansson" has been adopted by leading concerns because it is properly designed and properly made and in the long run the most economical snap gage on the market.

Shall we send you a Johansson Snap Gage for inspection?



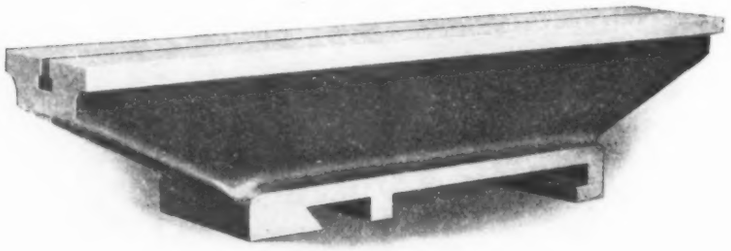
Anyway, write for a copy of our latest free book on Johansson Gaging System.

GRONKVIST DRILL CHUCK COMPANY

18 MORRIS STREET **JERSEY CITY, N. J.**

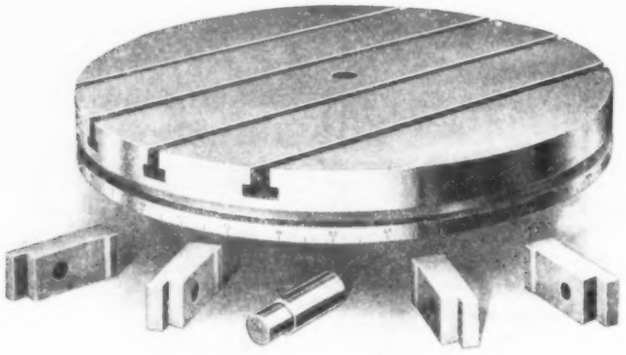
The Attachments for

The Universal (Horizontal) Boring Machine



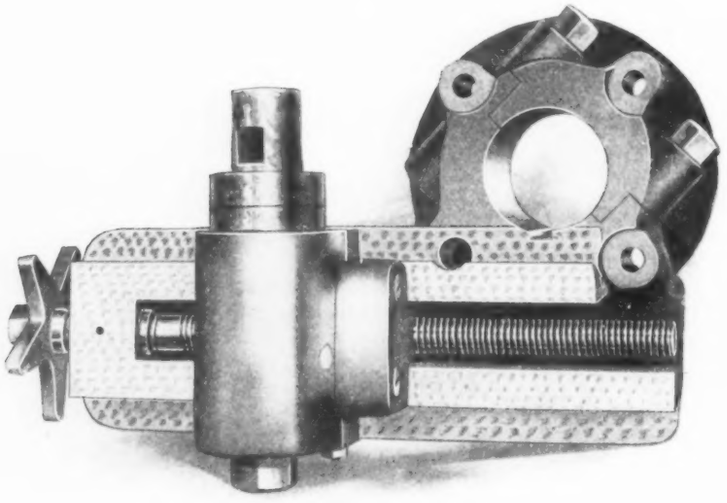
The Auxiliary Table

Whenever our boring machines are installed shop methods are revolutionized



The Rotary Table

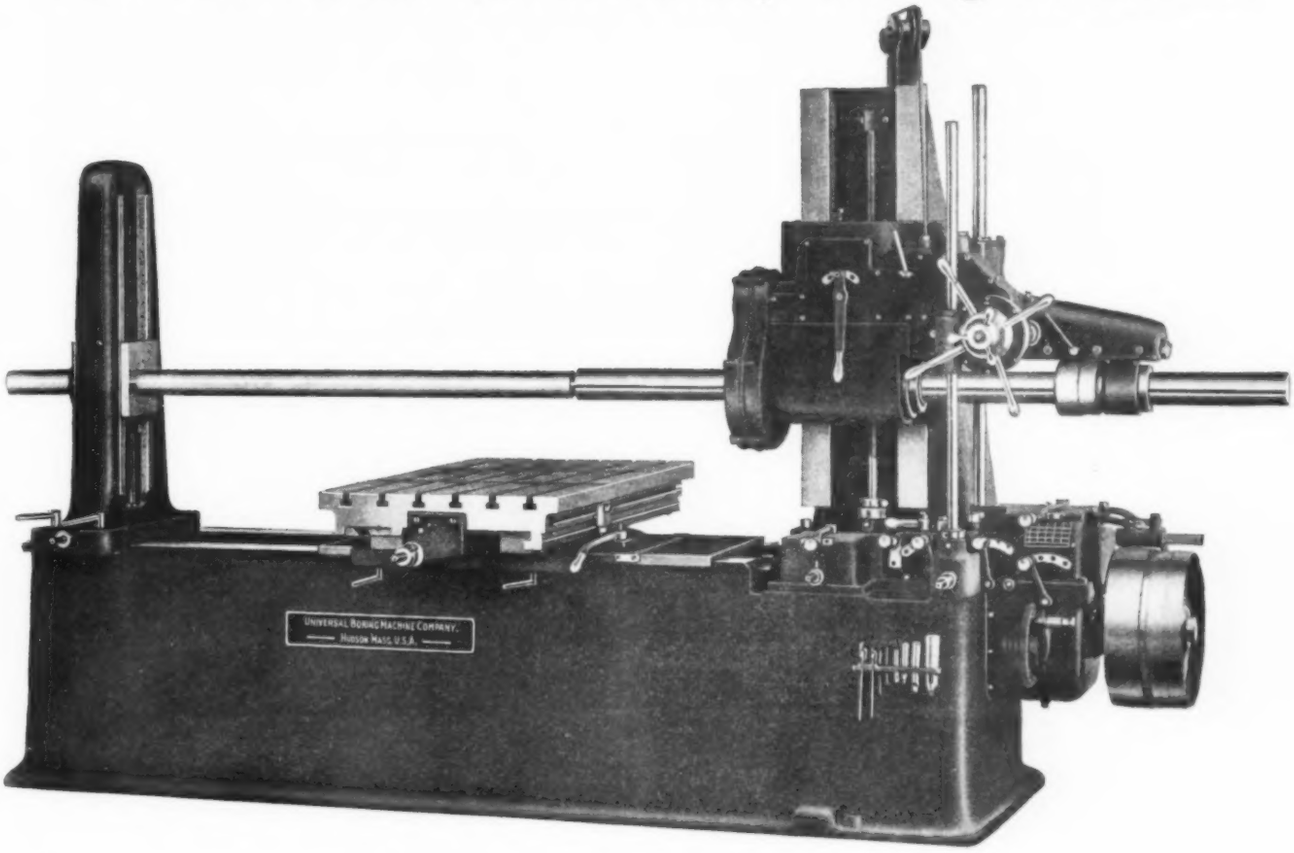
Our boring machines are justly celebrated for accuracy



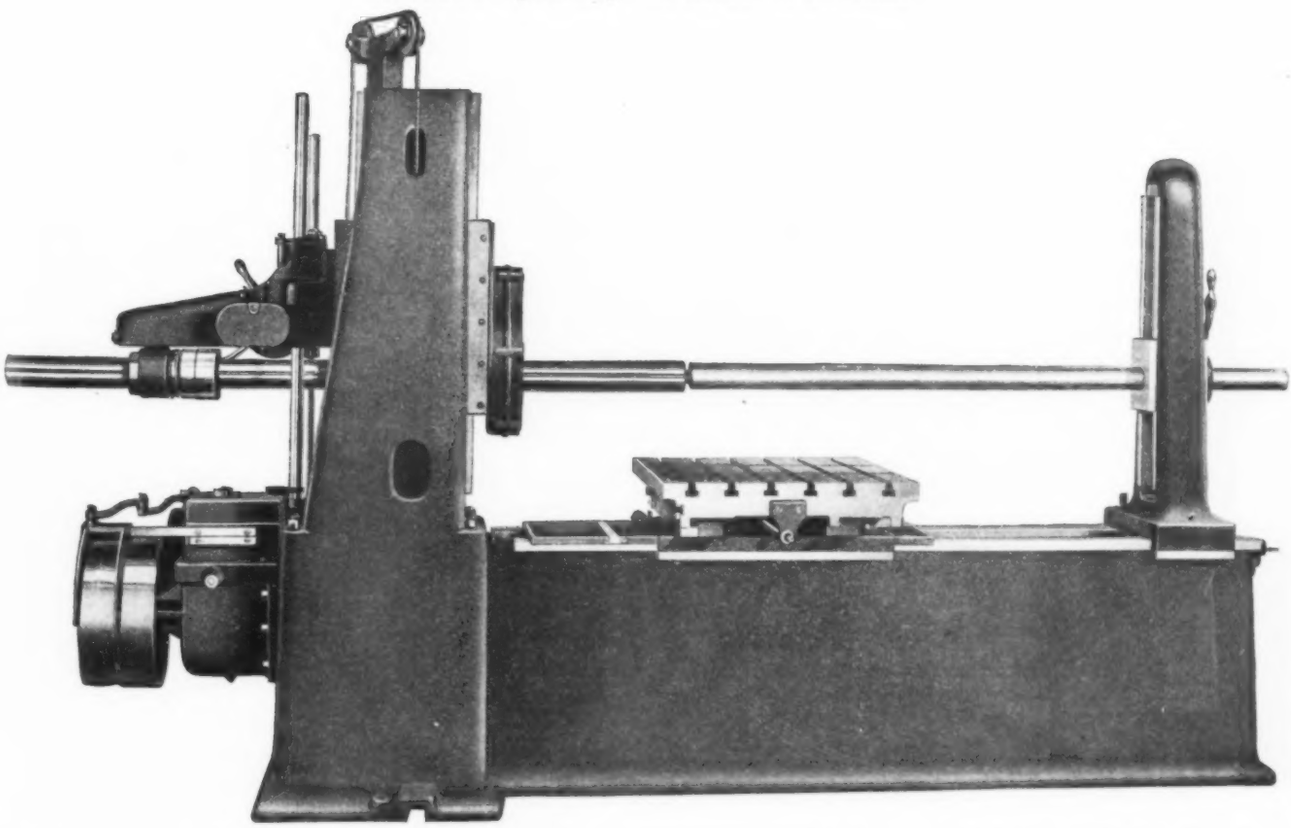
The Facing Head with Star Feed

Universal Boring Machine Co., Hudson, Mass., U. S. A.

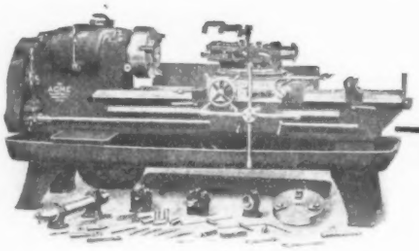
The Universal (Horizontal) Boring Machine



Where quality counts we win.



Universal Boring Machine Co., Hudson, Mass., U. S. A.



Cincinnati Acme

The People To Write To

When the question of manufacturing lathes comes up there's a big difference whom you write to.

You want more than the machine you get in the transaction. You want service, good-will, lasting satisfaction.

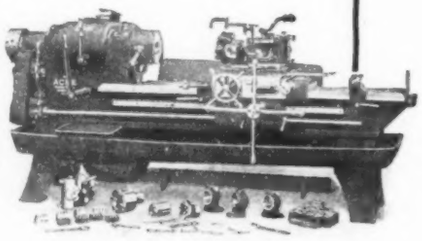
So we say, investigate the **Cincinnati-Acme.**

Our Flat Turrets handle both bar and chucking work.

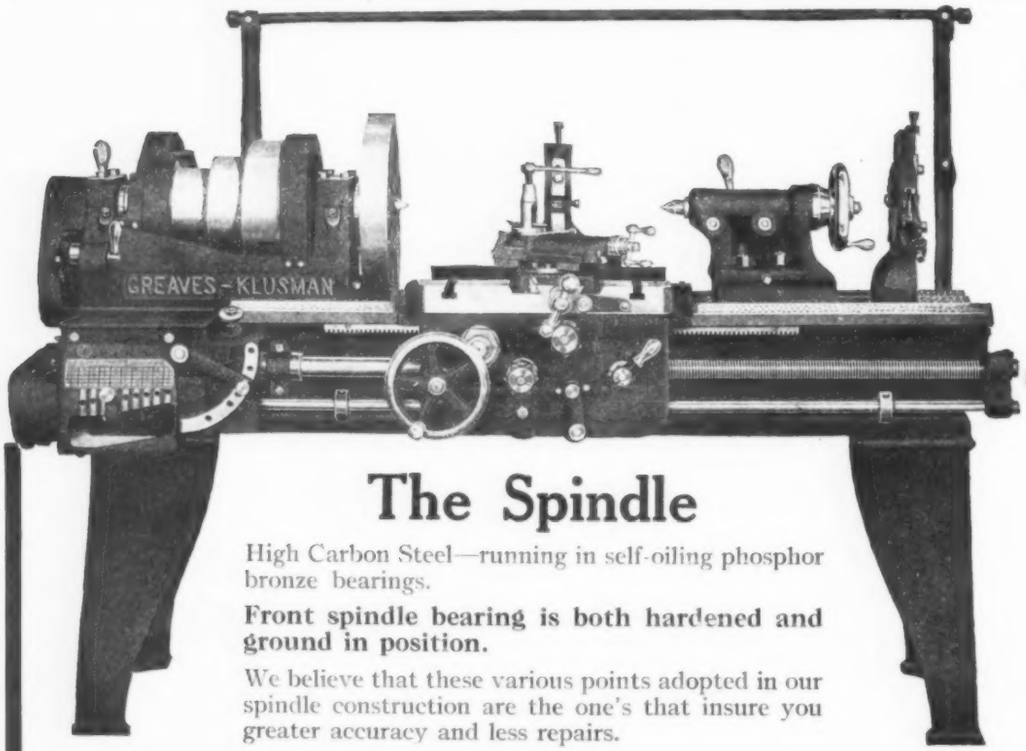
We help you pick your machine out; we help you to make a success of it.

Cincinnati-Acme Flat Turret Lathes in two sizes. Also a complete line of high type Turret Lathes and Screw Machines.

May we send bulletins?



The Acme Machine Tool Co.
Cincinnati, Ohio
Manufacturers of a full line of Screw Machines and Turret Lathes



18"—3 Step Heavy Quick-Change Lathe

The Spindle

High Carbon Steel—running in self-oiling phosphor bronze bearings.

Front spindle bearing is both hardened and ground in position.

We believe that these various points adopted in our spindle construction are the one's that insure you greater accuracy and less repairs.

Special Bulletin is ready.

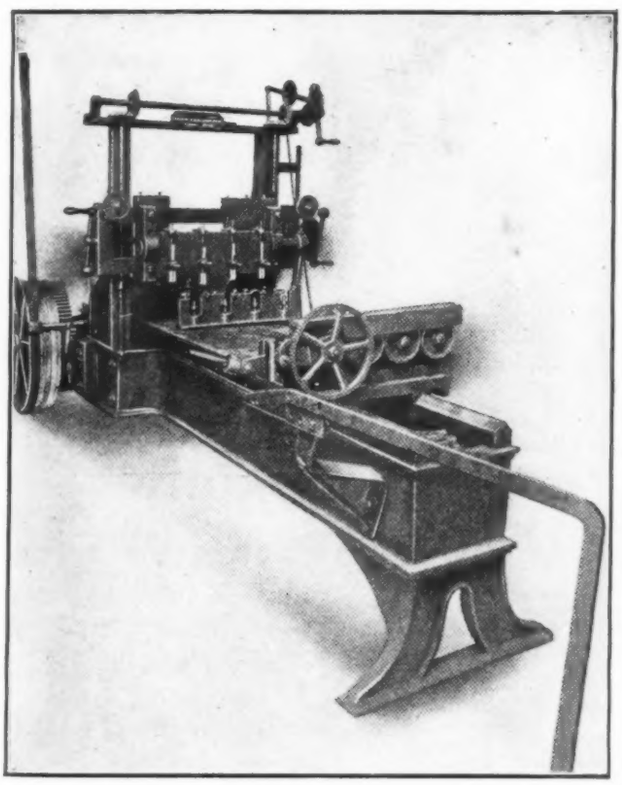
The Greaves-Klusman Tool Company
Cincinnati, Ohio

1751

THE HISTORY OF THE PLANER

1915

1844



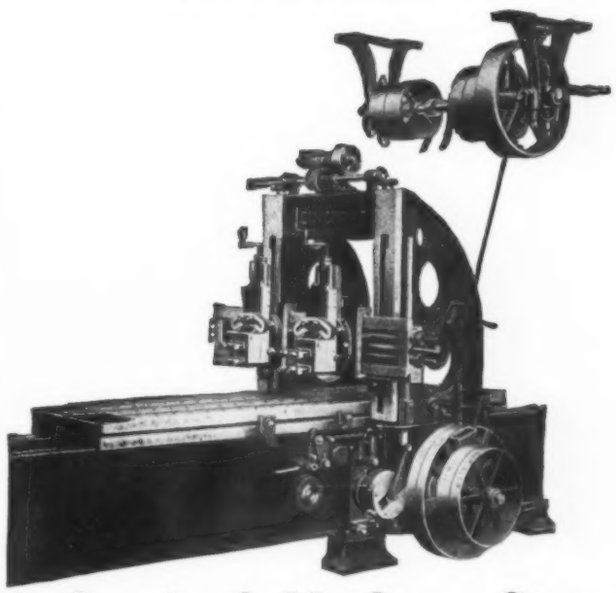
A Heavy Tool for Date and Size

The name plate, Gay Silver & Co., North Chelmsford, Mass., 1844, fixes its age exactly.

Table is 27 inches by 8 feet and is driven by means of a chain.

This tool formerly had a lifting device for the tools, the same as the stone bed planer described two weeks ago, but subsequently the single head was replaced by a wide casting carrying four tool posts. This arrangement is used for fluting textile rolls and is considered more satisfactory than milling, both as regards quality and quantity of work produced, the device for fluting the rolls is automatic in action, the spacing being accomplished by the pawl lever sliding up the inclined flat iron track on the return stroke of the planer.

1915



A Logical Modern Step In Planer Advancement

The **Cincinnati Tu-Speed Planer.**

With this machine in operation two speeds are acquired—

The right speed for roughing.

The right speed for finishing.

Two cutting speeds to the table and a constant return. The changing from one to the other is accomplished instantly while the machine is running.

You are losing money if you are attempting to get along with one speed. The single speed planer is handicapped.

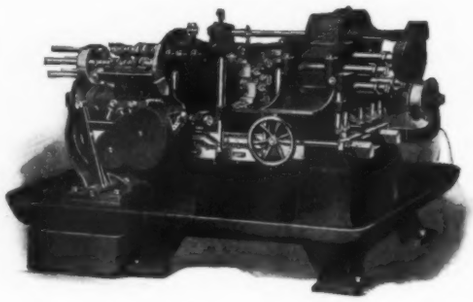
In the history of the planer the **Cincinnati Tu-Speed Planer** stands out as one of the latest and biggest improvements.

Cincinnati Planer Co., Cincinnati, Ohio, U. S. A.

The One Hundred Per Cent. Machine

Hayden Automatic Screw Machine

5 Spindles.
16 Changes of Spindle Speed.
20 Changes of Time to Make One Piece.
9 Tools can be operated together.
5 Longitudinal Tool Slides for Turning, Drilling, etc.
3 Strainings of oil before it reaches suction pipe.
42 Other Features of Superiority.
100.0

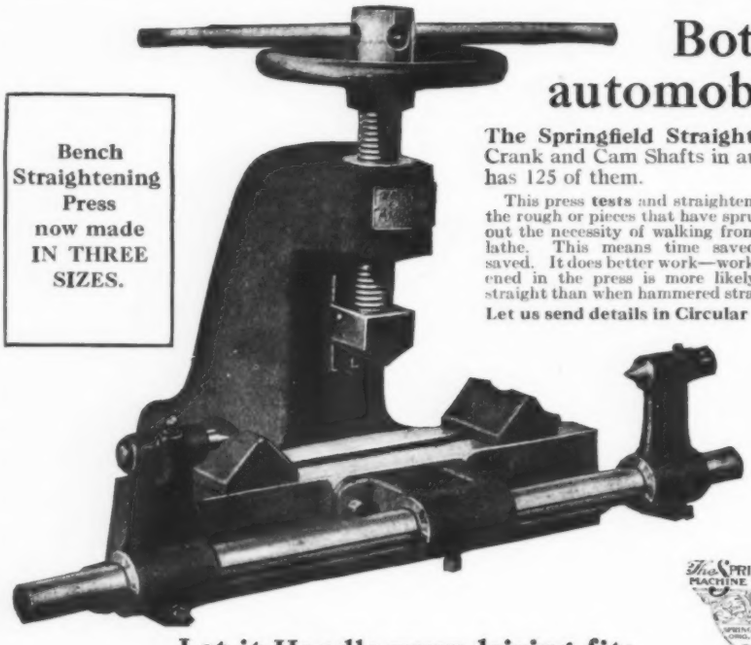


The Hayden Automatic is a new screw machine—a machine designed strictly for 1915 work and designed to increase production on such work.

We will gladly mail you the large catalog which fully describes the Hayden. We believe it will pay you to write for this catalog and study those 42 other features and learn what the Hayden can do in your shop. The catalog is free but let's hear from you now.

Cincinnati Automatic Machine Co., Cincinnati, Ohio

Bench Straightening Press now made IN THREE SIZES.



Both money savers for automobile manufacturers—

The Springfield Straightening Press is most essential for straightening Crank and Cam Shafts in automobile manufacture. One large company alone has 125 of them.

This press **tests** and straightens work in the rough or pieces that have sprung, without the necessity of walking from press to lathe. This means time saved—money saved. It does better work—work straightened in the press is more likely to stay straight than when hammered straight.

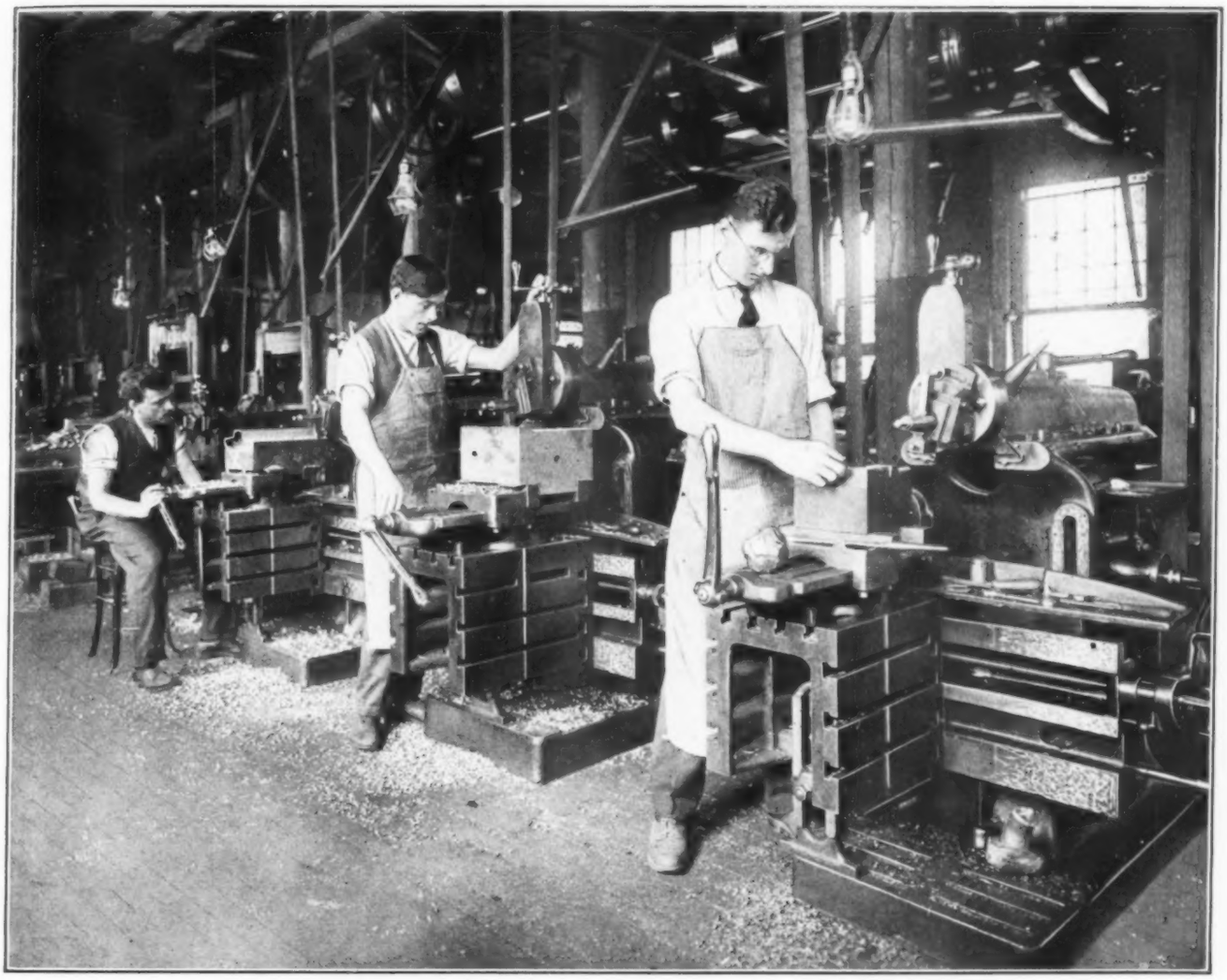
Let us send details in Circular No. 101.

Pneumatic Shop Press

Let it Handle your driving fits

The Springfield Pneumatic Press. It is a much more economical way of handling your driving fits than by the old method of bar and nut. Works more rapidly, easier, is peculiarly sensitive. It's a time saver you should know about. **Write today for Bulletin 128.** We are also manufacturers of a full line of lathes. "Ideal" and "Standard", 14" to 42" swing and Crank and Back Geared Shapers from 12" to 25" stroke. Catalog on request.

The Springfield Machine Tool Company
Springfield, Ohio, U. S. A.



What the Billings & Spencer Co. Says About G & E Shapers—

The shapers in this photograph are shown cutting offsets in drop forge dies. We know of no other machine that adapts itself so well to this particular class of work.

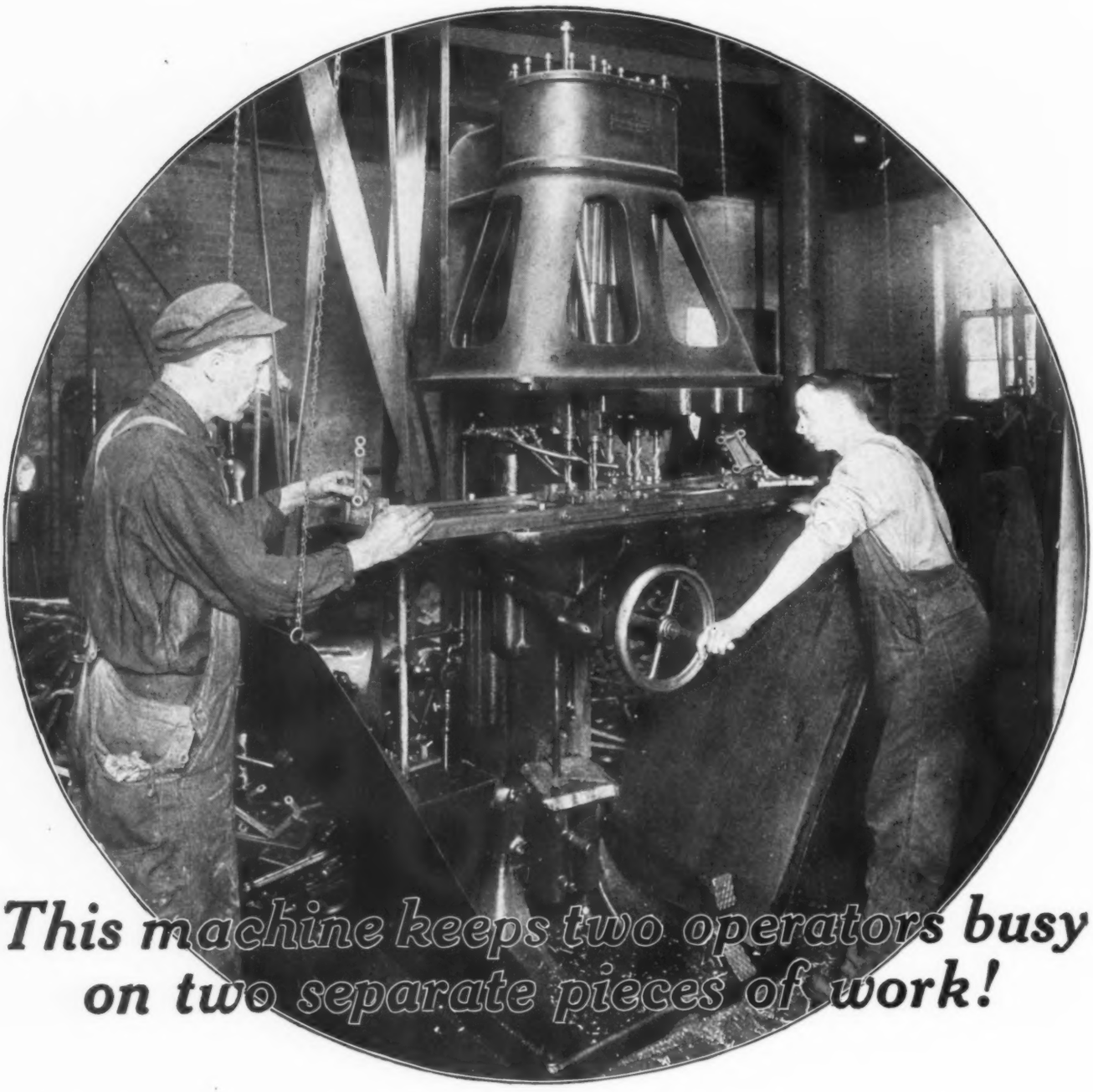
"The fact that we have purchased Gould & Eberhardt Shapers exclusively in the past seven or eight years, is evidence that, in our opinion, this particular shaper is as good as can be secured for our work.

"We have at the present time eight (8) of these machines in constant operation and consider them high grade in every respect."

How about G & E Shapers for you?
Write for further particulars.

GOULD & EBERHARDT
"HIGH DUTY" SHAPERS
AUTOMATIC GEAR AND RACK CUTTING MACHINERY
ESTABLISHED 1853 NEWARK, N.J. U.S.A.

Newark, N. J.



This machine keeps two operators busy on two separate pieces of work!

"UNIVERSALLY ADJUSTABLE" NATCO MULTIPLE DRILLS

This illustration shows a method of multiple drilling that is applicable to many jobs.

On one side of this NATCO one piece is drilled with an average of 2,250 holes, 21/64″ diameter, 1″ deep; on the other side of the machine an entirely different piece, looked after by another operator, is being drilled with an average of 2,300 holes, 21/32″ diameter, ¾″ deep. The pieces are drop forgings.

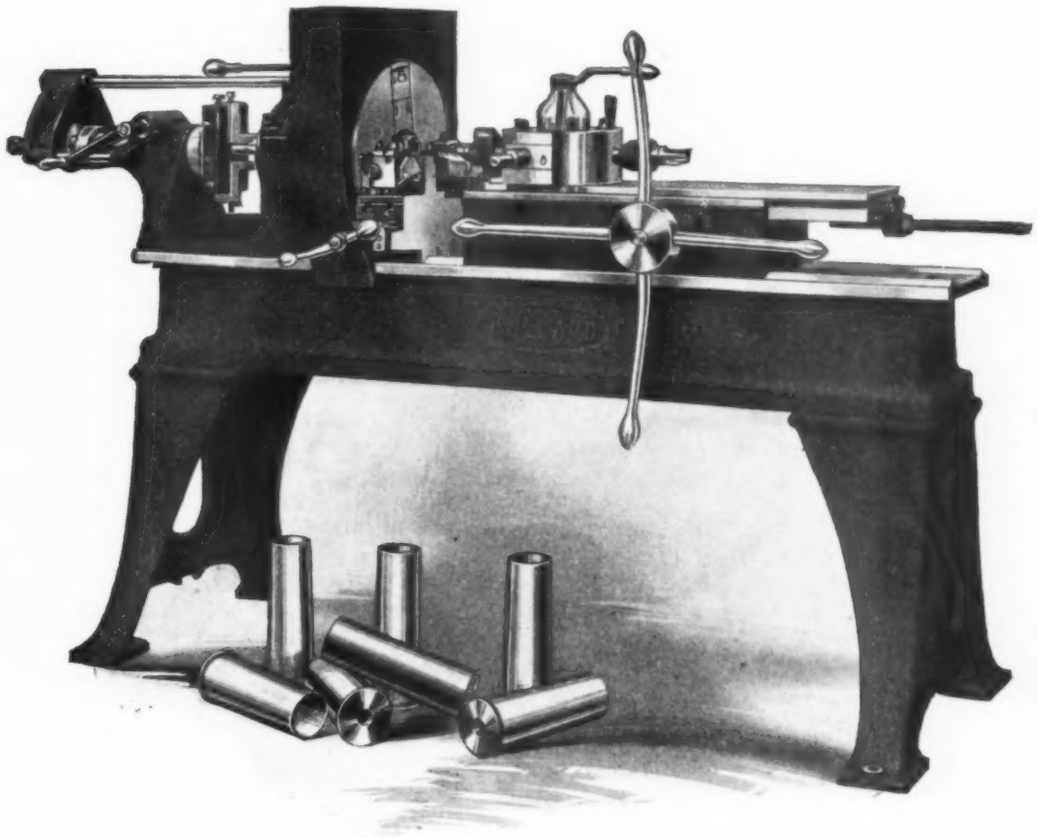
Each operator handles two sets of jigs which you will note are arranged in track form; while the machine is drilling one set, the other is being filled by the operator.

The photograph was taken recently in the plant of the Tessmer Machine & Tool Co. of Detroit and shows only one of the many different operations which is being performed on this machine. Says Mr. Tessmer, "We have found this to be a paying investment over the old single drilling operations."

On no other Multiple could this work be done so economically and fast as on this NATCO because of the patented Independent Drill Speeds which enables them to drill the 21/64″ and 21/32″ holes at the same time at their correct cutting speeds.

Why not adopt this "paying investment" in your plant? We shall be glad to furnish you full particulars regarding the size of machine best fitted to your work.

THE NATIONAL AUTOMATIC TOOL CO., RICHMOND, IND., U. S. A.



From Monday 'til Saturday—

A Week's Output of a Battery of 19 Bullard Cartridge Case Finishing Machines

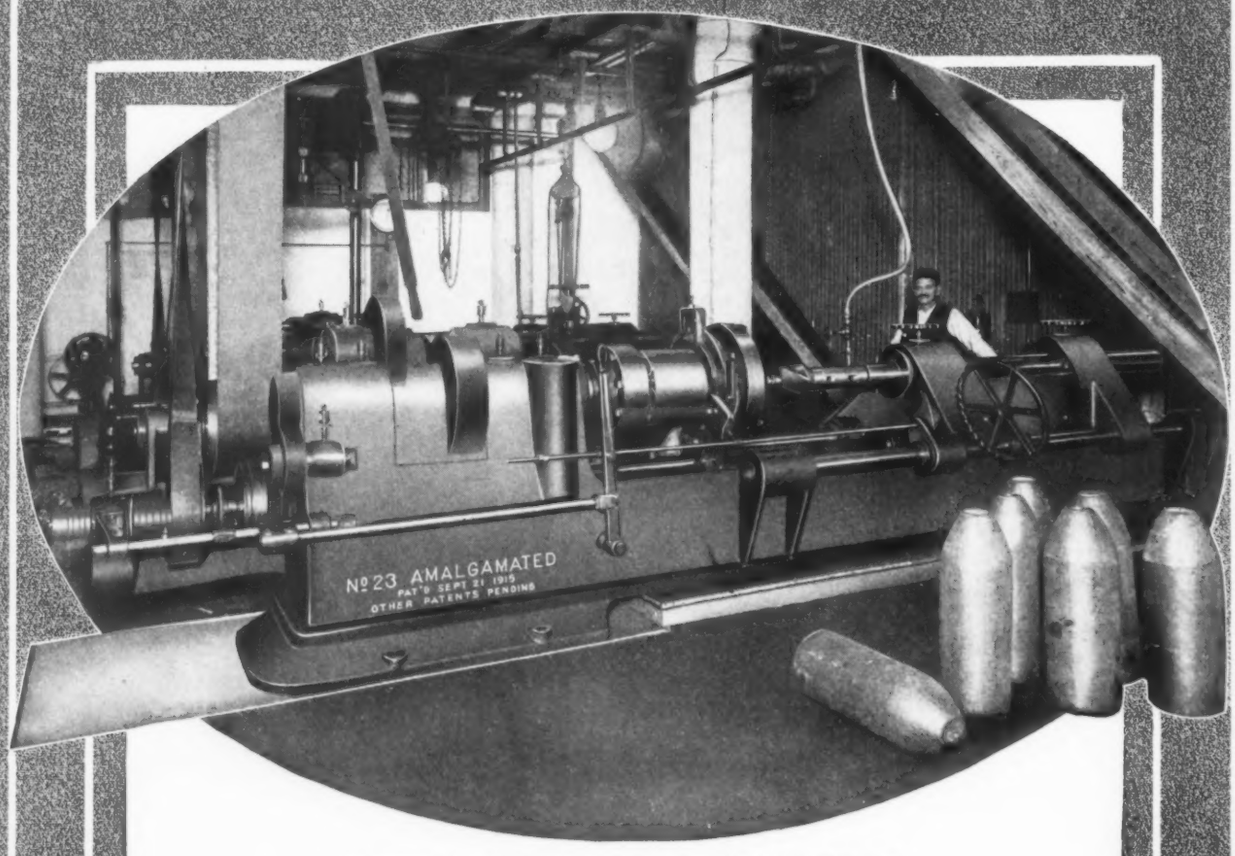
The work was on British 18 pounder shells, in a certain ammunition plant—

	Day	Night
Mon.	8170	6886
Tues.	8020	8228
Wed.	7910	5973*
Thur.	4403*	6286
Fri.	6177	5183*
Sat.	6848	5803*

* shortage of work from the presses.

One man turned out 55 cases per hour for 11 1/4 hours. Get the full particulars about these remarkably productive machines.

Bullard Machine Tool Company
Bridgeport, Conn.



Amalgamated No. 23 Drilling Machine boring British 9.2″ H.E. Shell

Can you finish that contract on time? Yes! if you order now—

AMALGAMATED AMMUNITION-MACHINERY

All roughing and finishing operations on High Explosive Shells and Shrapnel can be done on these single-purpose machines in record time. There is a machine for turning, another for boring, another for drilling, etc.

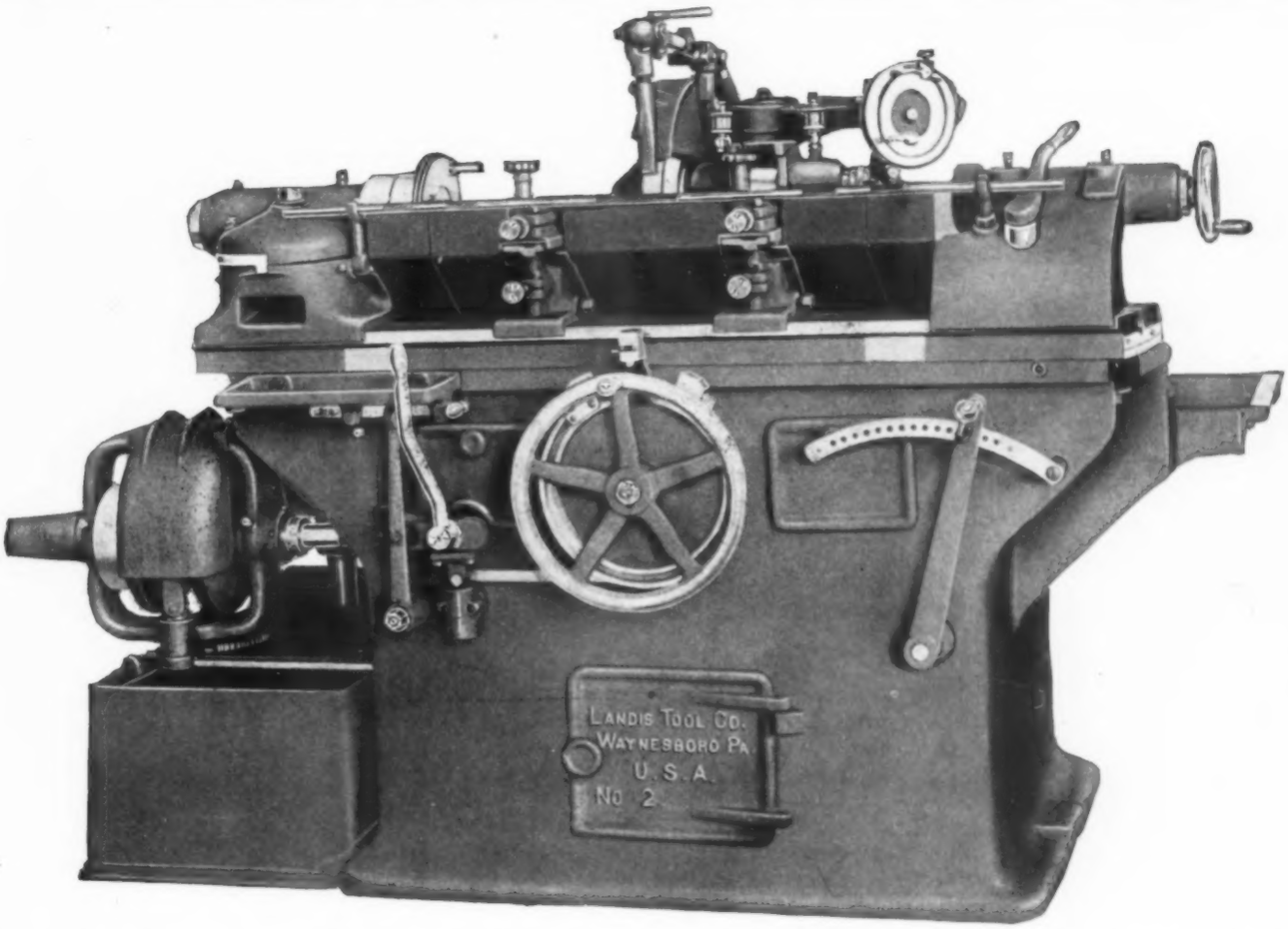
The best part of it is, that we can promise you early deli ery—and li e up to that promise. Look at the typical Amalgamated Ammunition Machine shown above. Its sturdiness is representative of the entire line.

We have a catalog which describes each type w th minutest detail. Send for a copy now.

Amalgamated Machinery Corporation

72 West Adams Street, Chicago, U. S. A.

LANDIS



LANDIS UNIVERSAL GRINDING MACHINES ARE EASY TO OPERATE

The manipulation is so simple that an inexperienced man can readily learn the operations and by application rapidly increase his output.

The feeds are automatic and the sizing device permits the operator to prepare work, while grinding, for the succeeding operation.

Provision is made for a constant supply of water, which reduces the tendency of the wheel to glaze, enabling it to cut freely and rapidly; it also prevents the work from heating, making gauging and sizing definite, and eliminates the grinding dust which is so disagreeable to the operator.

Speed changes can be made quickly and independently.

The traverse and work speeds can be regulated to suit the work, permitting a slow work and fast traverse speed for removing stock, and vice versa, for fine finish.

Results of these points are increased output.

Landis Tool Company,

Main Office and Works:
Waynesboro, Pa., U. S. A.

Universal Grinding Machines
Crank Grinding Machines
Plain Grinding Machines
Internal Grinding Machines
Roll Grinding Machines
Cam Grinding Machines

New York Office: Fulton Building, 50 Church Street, Walter H. Foster Co., Managers

AGENTS: Dewstoe Machine Co., Birmingham, Ala. Harron, Rickard & McCone, San Francisco and Los Angeles.

LANDIS

AN R-P CUTTING-OIL SYSTEM WOULD HAVE PREVENTED THIS

This four-story machine shop was entirely gutted by fire. The fire started in the cutting oil and the inflammable vapors caused the fire to spread so quickly that practically the entire building was destroyed.

This shows the danger of having large quantities of cutting oil around in machines and in open ducts and tanks. You might think your cutting oil is non-inflammable, but a little heat makes it give off inflammable vapors and subjects your plant to a catastrophe like this.

The only safe way to handle cutting oils is by means of a continuous closed system such as the Richardson-Phenix System which has been installed in a number of plants. With this System the fire hazard is practically eliminated, because the oil fed to the various machines instantly passes off into the drain pipe. No oil is kept in the base or reservoirs of the machines and the small quantity adhering to the cuttings is not sufficient to support a fire. The gravity oil reservoir and filter can, if desired, be located away from the main building or in a fire-proof vault.

This system is better protection than a fire insurance policy and the cost is surprisingly small.

The other advantages of continuously filtering, and when necessary, sterilizing cutting oil and of always using clean oil are thoroughly discussed in our new Book R-110. A copy is yours for the asking.

THE RICHARDSON-PHENIX CO.

LUBRICATION ENGINEERS AND MANUFACTURERS

WORKS: 119 RESERVOIR AVENUE MILWAUKEE, WIS.

503

TRADE
THE MARK THAT STANDS
STANDARD TOOL CO.
MARK
FOR HIGHEST QUALITY

THE STANDARD TOOL CO'S
FURNISHED IN ALL STYLES

New York
94 Reade Street

Prices on application
CLEVELAND

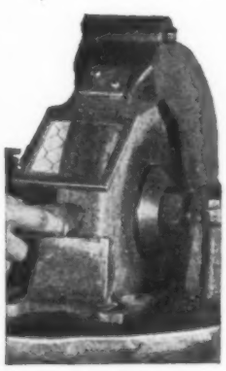
Chicago
552 W. Washington Blvd.

Representatives in Principal Foreign Cities.

"SHIELD BRAND" DRILLS

That's a bad one, Jim—

Jim's eyes are one of his biggest assets. They are valuable to you, too, because they enable him to do that skillful work. If one of those splinters or chips from the lathe, or the shaper, or the grinding wheel permanently injures Jim's eyes, both of you lose. *He* loses an eye. *You* lose damages or compensation claims and a skilled man trained in your work.



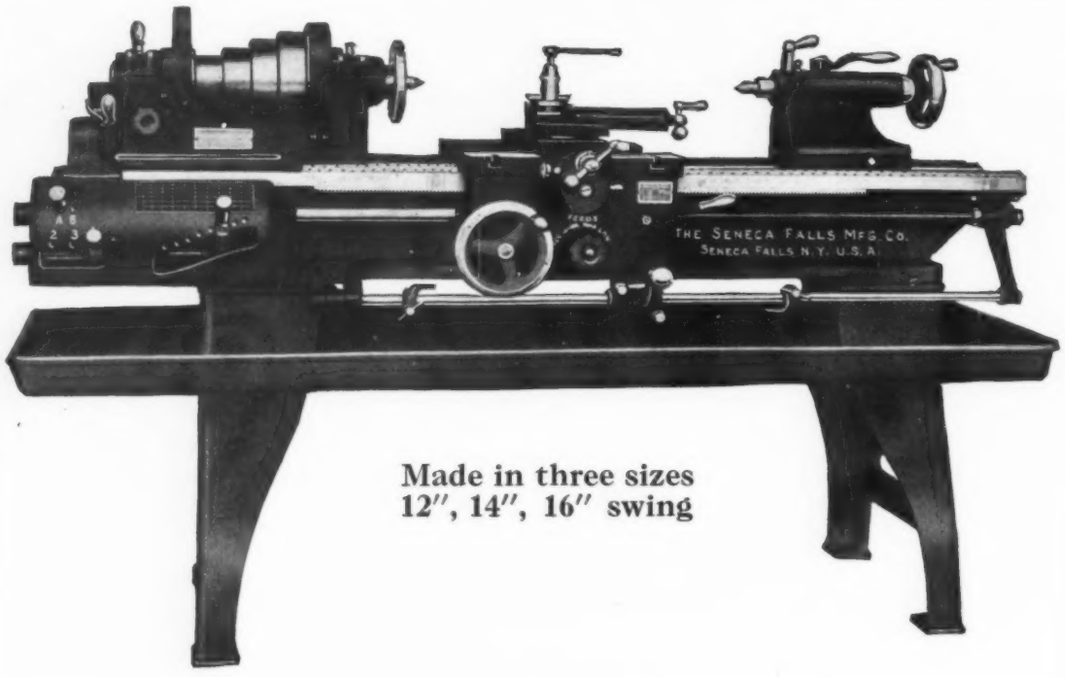
Men won't wear goggles because they are clumsy, inconvenient and uncomfortable Yet, if an eye is lost, *you* have to pay. Protect yourself and your men with Universal Eye - Guards like the one on the grinding wheel here.

It is cheaper to equip with Universal Eye Guards than to pay for eyes. Send a check.

Guard for Grinding Wheel	**$2.00**
Guard with bracket for Shaper	**$3.00**
Guard with Bracket for Lathe	**$3.50**

Safety Engineering Company
1440 Schofield Bldg., Cleveland, O.

SENECA FALLS



Made in three sizes
12″, 14″, 16″ swing

The Lathes for Long Run Economy

The quality of "Seneca Falls" Quick Change Engine Lathes is not a condition, a mere "happenstance"—it is a *policy*—something we cannot help doing. A policy firmly established, after years of research and study, with this result: Lathes that produce the *utmost* of quality work for the *least* money.

How do we know this? By the number of "repeat" orders we're booking for lathes of every nature. And "repeat" orders *come only* as a result of *satisfaction* derived from the *first*.

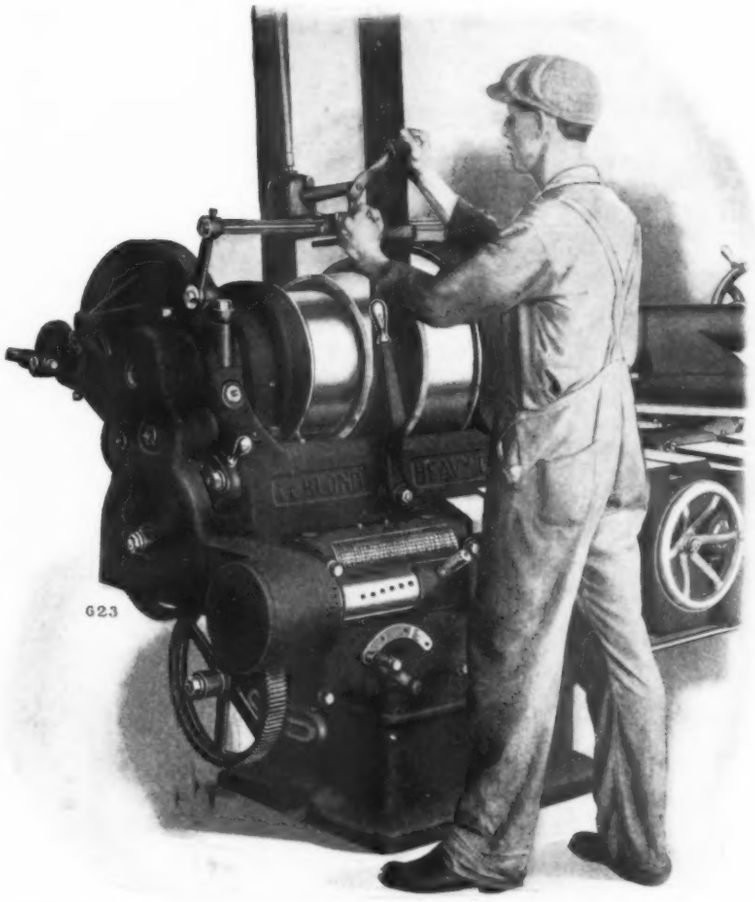
We support our confidence in these Lathes with a guarantee that *really* guarantees.

Shall we forward a copy of our new Catalog "26-B?"

The Seneca Falls Mfg. Co.

687 Water Street **Seneca Falls, N. Y.**

Canadian Sales Agents: The Canadian Fairbanks-Morse Co., Montreal, Toronto, St. John, N. B.; Calgary, Saskatoon, Winnipeg, Vancouver, Edmonton, Ft. William, Hamilton, Ottawa, Quebec; Regina, Victoria.



This Man

is shifting a 6-inch driving belt as easily and safely as the speed changes are made with a selective gear change mechanism.

The LE BLOND
Patent Belt Shifter

can be applied to any cone-driven machine tool of any manufacture at practically no investment and will practically convert it into a single pulley drive machine.

The R. K. Le Blond Machine Tool Company
Cincinnati, Ohio

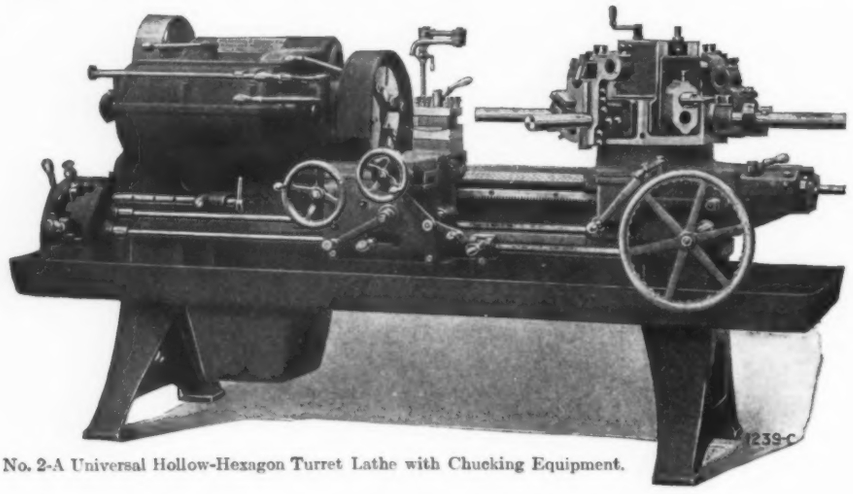
1248 Standard Size Bunting Bushings are Listed in This Book

It's the Bunting Price List, a sixteen page booklet which lists every standard size of bronze bushing from $\frac{1}{2}$" O.D., $\frac{1}{4}$" I.D., by $\frac{1}{2}$" long to $3\frac{3}{8}$" O.D., by 5" long. There are over twelve hundred of them—1248 to be precise—and we're ready to supply any one of them in lots of 100 and more completely machined and ready for use.

If you don't find the bushing you want in our price list—if you want bushings of special size or design—we can supply you promptly, following your drawings or blueprints with accuracy and care.

We can sell you high grade bushings cheaper than you can make them. You doubt it? Then write for price list "T."

The Bunting Brass & Bronze Co.
726 Spencer St., Toledo, Ohio



No. 2-A Universal Hollow-Hexagon Turret Lathe with Chucking Equipment.

Accuracy First and Last

In designing the various features that assure unusual rapidity of production, one thought has always been uppermost: *to conserve the characteristic accuracy of*

Universal Hollow-Hexagon Turret Lathes

With the head and bed cast in one piece, the ability to use short, stiff turret tools and the rigid support of the tools, spring and chattering are reduced to the minimum. These features assure accuracy from the beginning.

And with the various means provided for taking up wear, long life is assured—with accuracy to the end. We don't know of a single instance where loss of accuracy has impaired the usefulness of a Universal Hollow-Hexagon Turret Lathe.

Write for Descriptive Circular or call at any of our offices.

THE WARNER & SWASEY COMPANY

CLEVELAND, OHIO, U. S. A.

TURRET LATHES—TURRET SCREW MACHINES—BRASS WORKING MACHINE TOOLS

NEW YORK Office-Singer Bldg. **Boston Office**—Oliver Bldg. **Buffalo Office**—Iroquois Bldg. **Detroit Office**—Ford Bldg. **Chicago Office and Show Rooms**—618-622 Washington Blvd.

FOREIGN AGENTS: Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. Schuchardt & Schutte, Berlin, Vienna, Budapest, Petrograd, Stockholm, Copenhagen, Shanghai and Tokio. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Bilbao and Barcelona. Benson Brothers, Sydney. A. Asher Smith, Sydney. A. R. Williams Machinery Co., Ltd., Toronto, St. John, Winnipeg and Vancouver. Williams & Wilson, Ltd., Montreal.

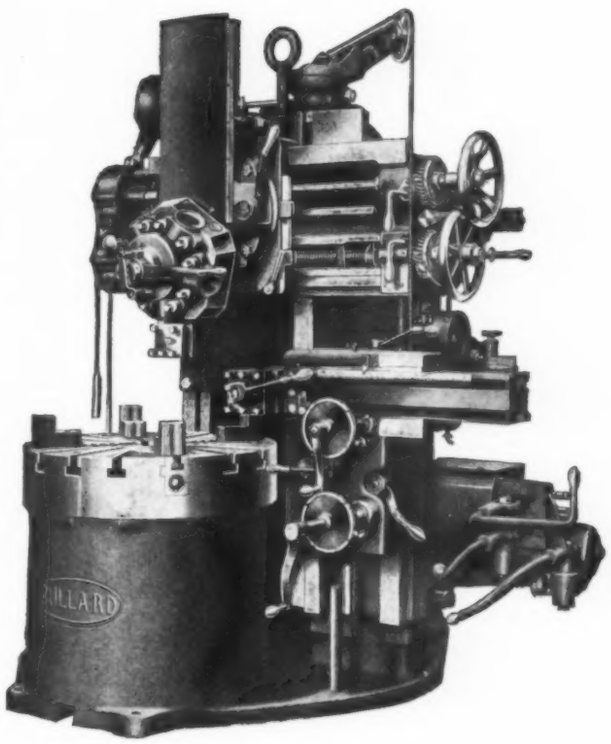
The Bullard Reclamation service

To reclaim time lost in getting ready to cut:—
Vertical Construction which makes chucking an easy matter.

To reclaim time lost between cuts:—
Power Operated Parts—Centralized Control—Observation Stops reducing the time required for measurements to a minimum.

To reclaim time lost by breakage:—
Ample Power and Rigidity—Chrome Nickel Steel Gears, heat treated, practically indestructible — a complete and automatic system of Flooded Lubrication.

To make this reclaimed time multi-productive:—
Multi-cutting which enables two or more tools to cut simultaneously— Cutting Lubricant System taking the heat out of long, heavy cuts.



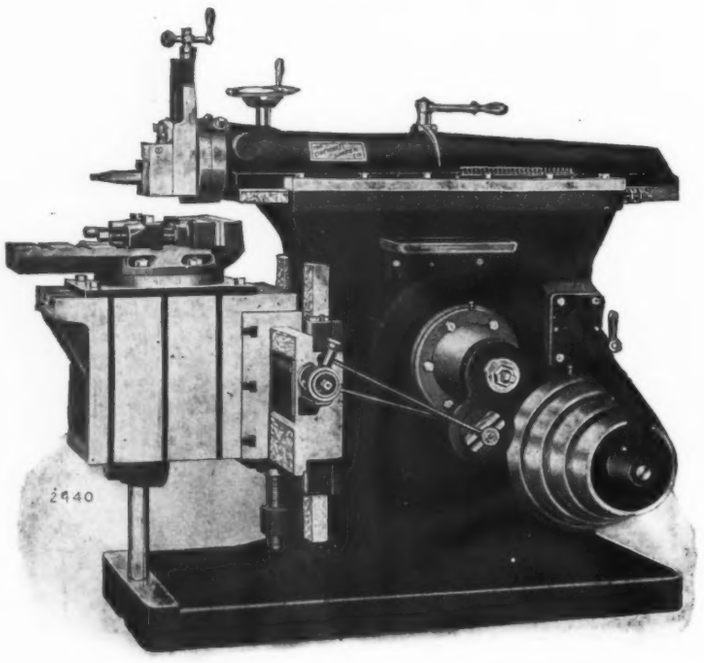
BULLARD

Turns waste time into productive time

Get acquainted with all the good points of the Bullard Vertical Turret Lathe. It will pay and interest you.

The Bullard Machine Tool Company

Bridgeport, Conn., U. S. A.



The Freakish Job Is a Cinch for This Shaper

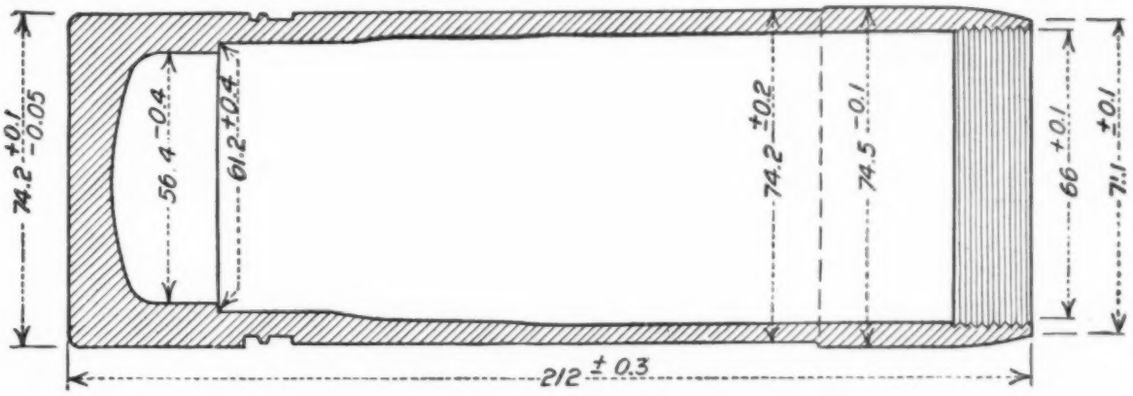
JOBS which may be called unusual come oftener than is sometimes thought. We don't mean isolated machining jobs of only one piece, but unusual runs of work that may be necessary unexpectedly.

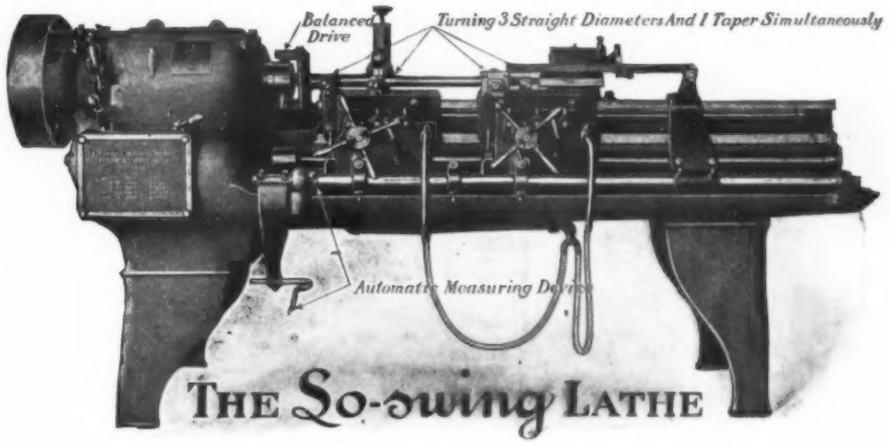
For such contingencies the Cincinnati Shaper is the best bet. It is a machine of almost infinite applications—sturdily built for speed and accuracy.

Get our catalog and see details. Are *YOU* aware of the possibilities of shapers.

The Cincinnati Shaper Co., Cincinnati, Ohio

AGENTS—Manning, Maxwell & Moore, Inc., New York, Lincoln Bldg., Philadelphia, Chicago, Boston, St. Louis, Leader News Bldg., Cleveland, Buffalo, Detroit, Milwaukee; Brown & Zortman Machinery Co., Pittsburgh; The National Supply Co., Toledo, O.; Eccles & Smith Co., San Francisco, Calif.; Zimmerman-Wells-Brown Co., Portland, Ore.; The Galigher Machinery Co., Salt Lake City; C. T. Patterson Co., Ltd., New Orleans; The General Supply Co. of Canada, Ltd., Toronto and Ottawa; Andrews & George, Yokohama; Charles Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne, Glasgow; A. H. Schutte, Cologne-Deutz, Berlin, Brussels, Paris, Milan, Barcelona, Bilbao and Petrograd; McPherson's Proprietary, Ltd., Melbourne, Sydney; Donauwerk Ernst Krause & Co., Vienna, Prague and Budapest.




Balanced Drive
Turning 3 Straight Diameters And 1 Taper Simultaneously
Automatic Measuring Device
THE So-swing LATHE

High Explosive Shells

are made with great facility on the *So-swing* Lathe because of the manufacturing scheme of MULTIPLE TOOL production.

In machining the outside of the shell the tools are arranged so that the entire operation may be accomplished at one setting, the piece being held on an especially arranged arbor.

When machining the inside the same advantages apply, the entire work including threading the nose being done at one setting, the piece being held by a special chuck.

Fitchburg Machine Works

Fitchburg, Mass., U. S. A.

Sold direct by our own representatives in United States and Canada.

Foreign Representatives: Buck & Hickman, Ltd., London, Birmingham, Manchester and Glasgow. Allied Machinery Co. of America, 3 Rue Paul Dubois, Paris, for France, Switzerland, Italy. The F. W. Horne Co., Tokyo, for Japan.

Die-Cut Threads True to Pitch

Accuracy in die-cut threads equal to that obtained by threading on an ordinary engine lathe is possible with the Hartness Automatic Die. The following features make this possible:

1. The chaser acts as a lead-screw nut on the finished work. Note the bright bearing in the picture, on the rear threads.

2. The pitch of the chaser, which thus determines absolutely the pitch of the work, is made extremely accurate. It is subject to but one hardening error. Errors in the cutter, with which its teeth are milled, are compensated for.

When necessary, we can furnish chasers with a pitch error not to exceed .001 inch per inch in length.

JONES & LAMSON MACHINE COMPANY,
(Automatic Die Dept.)
Springfield, Vermont, U. S. A.
97 Queen Victoria, St., London, E. C.

BOYER-CAMPBELL CO. Detroit, Mich.
E. L. ESSLEY MACHINERY CO. Chicago, Ill.
W. M. PATTISON SUPPLY CO. Cleveland, O.

AMERICAN AGENTS FOR DIES AND CHASERS:
ROBINSON, CARY & SANDS CO. St. Paul, Minn.
CAREY MCHY. & SUPPLY CO. Baltimore, Md.
BARWOOD-RICHARDS MACHINERY CO. The Bourse, Philadelphia, Pa.

PACIFIC TOOL & SUPPLY CO. San Francisco, Calif.
E. A. KINSEY CO. Cincinnati, O.
Indianapolis, Ind.
MACHINISTS SUPPLY CO. Pittsburgh, Pa.

Simonds

Every Tooth Cuts

The Hard Edge is Unbreakable Under Ordinary Use

Simonds Hard Edge Hack Saw Blades do not break.

This means fewer blades and fewer delays.

"Simonds" will cut any kind of metal, do not shell teeth and are practically unbreakable. Examine Simonds Blades at your Dealers. **Write for prices.**

Simonds Manufacturing Co.
Fitchburg, Mass.

Chicago Ill. New York City San Francisco, Cal.
8 White St., Moorfields, London, E. C., England.

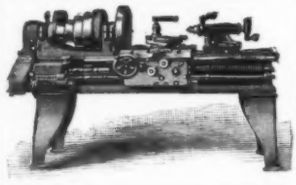
SIMONDS

DIAMOND TOOLS

hold their cutting edges for months. Can easily be sharpened and will last for years. Leave a smooth, true and finished surface. These special shaped carbon, black diamond, pointed tools are best for turning paper, cotton, corn husk, rag, fibre, hard rubber, etc.

They turn out a large number of pieces of exact uniform size.

THOS. L. DICKINSON,
66 Nassau St. New York
Successor to John Dickinson. Estab. 1796.
C. W. Burton, Griffiths & Co., London, Sole Agents for Great Britain.



ENGINE LATHES
10-12-14-16 and 18-Inch Swing

any length Beds, Quick Change or New Standard. Countershaft or Motor Drive, and with or without Taper Attachment, Draw-in Attachment, Turrets, Chucks Tools, etc., *Send for Catalogue.*

CHAMPION TOOL WORKS CO.
2424 Spring Grove Ave., Cincinnati, Ohio.

Black Diamond Files & Rasps

Perfect Always

Twelve Medals Awarded at International Expositions

FOR SALE EVERYWHERE
Copy of Catalog will be sent free to any interested file user on application.

G. & H. BARNETT CO., PHILADELPHIA, PA.
Owned and Operated by the Nicholson File Co.

L. W. Mathias is constructing a garage and repair shop at 2316 13th St., Sacramento, Calif.

The Santa Fé R.R. Co., San Diego, Calif., contemplates the construction of a roundhouse and machine shops in Old Town, near San Diego.

The Ford Motor Co. will construct a five-story addition to its assembling plant at 21st and Harrison St., San Francisco, Calif. J. B. Lund is Mgr.

Plans are being prepared for the construction of a five-story automobile distributing and repair plant at Van Ness Ave. and Bush St., San Francisco, Calif., for the Willys Overland Co. Estimated cost, $225,000.

M. L. Wright will construct a one-story garage on Valencia St., San Francisco, Calif. Estimated cost, $10,000.

A. G. Bartlett will construct a garage and machine shop at Santa Monica, Calif.

T. Clark contemplates the construction of a garage and machine shop at Ventura, Calif.

CANADA

The Canadian Electro-Products Co. will establish a plant at Montreal, Que., and install an electric furnace and other machinery for the manufacture of shells.

Fire recently destroyed the machine shop at Sebastopol and Leber St., Montreal, Que., of the Grand Trunk Ry. Co. Loss, $8,000. The shop will be rebuilt.

The Steel Co. of Canada is constructing a factory at Montreal, Que. Estimated cost, $24,000.

The Williams Manufacturing Co. will construct a foundry at Montreal, Que. Estimated cost, $15,000.

Fire recently destroyed the plant of the Eastern Canada Steel Co. at Quebec, Que. Loss, $10,000. L. H. Gaudry is Mgr.

The Canadian Briscoe Motor Co. has taken over the plant of the Dominion Carriage Co., at Brockville, Ont., and will enlarge same.

The Cobourg Steel Co. contemplates constructing a plant at Cobourg, Ont.

The Perfect Machinery Co. is constructing a machine shop at Galt, Ont. Estimated cost, $4,000. Noted Dec. 9.

The Canadian Cartridge Co., Ltd., will install new equipment and enlarge its plant at Hamilton, Ont. Estimated cost, $500,000. F. W. Bathlie, Pres.

The Monarch Machine and Tool Co. is remodeling a building at Ferguson and Young St., Hamilton, Ont., for the manufacture of high-speed machinery for the shell industry.

Colin Russel and R. J. Russel, Ft. Francis, Ont., will establish a plant at North Bay, Ont., for the manufacture of shells.

Keenan Bros., Ltd., Owensound, Ont., is in the market for a machine lathe, plane milling machine, etc.

The Peterborough Metal Products Co. will install new machinery in its plant on Aylmer St., Peterborough, Ont.

The Western Machinery Co., Lincoln St., Port Arthur, Ont., will move into a larger building and will install new equipment.

The plant of the Canadian Explosives, Ltd., at Perry Sound, Ont., which was recently damaged by an explosion will be rebuilt.

The Newell Manufacturing Co., manufacturer of brass goods, Patterson St., Ogdensburg, N. Y., is constructing a factory at Prescott, Ont. W. A. Newell, Ogdenburg, N. Y., is Treas. Noted Nov. 25.

The Canadian Steel Foundries is constructing an addition to its plant at Welland, Ont.

The Vacuum Street Cleaning Machine Co. will construct a plant at Windsor, Ont.

GENERAL MANUFACTURING

NEW ENGLAND STATES

Bowditch & Townsend will establish a factory on Gage St., Augusta, Maine, for the manufacture of baskets.

The Crocker & McElwin Manufacturing Co., manufacturer of paper, has awarded the contract for the construction of a one-story, 30x100-ft. addition to its plant at Holyoke, Mass.

The Fiberloid Co. has awarded the contract for the construction of a four-story, 6x39-ft. addition to its plant on Worcester St., Indian Orchard, Mass.

The contract has been awarded for the construction of a plant at Middletown, Conn., for Russell Manufacturing Co., manufacturer of webbing yarns and threads.

The Winsted Hosiery Co. has awarded the contract for the construction of a two-story, 48x64-ft. factory at Winsted, Conn.

MIDDLE ATLANTIC STATES

The contract has been awarded for the construction of a factory for the General Chemical Co. at Shadyside, N. J. (Edgewater post office).

The contract has been awarded for the construction of a two-story, 100x110-ft. manufacturing building for the Stokes Rubber Co., Trenton, N. J. Estimated cost, $12,500.

Plans being prepared for an acid plant at Paulsboro, N. J., for Harrison Bros. & Co., Inc., 35th St. and Grays Ferry Rd., Philadelphia, Penn.

Fire, Dec. 15, destroyed the plant of the Boyden Shoe Manufacturing Co., Newark, N. J. Loss, $200,000.

Fire, Dec. 16, destroyed the canning factory of James Roe, Tilghman, Md. Loss unknown.

SOUTHERN STATES

The German-American Mills, Draper, N. C., will build an addition to its plant.

A four-story addition will be built to the plant of the Woodruff Cotton Mills, Woodruff, S. C.

The Goodyear Tire and Rubber Co., Akron, Ohio, has awarded the contract for the construction of a plant for the manufacture of tires at Atlanta, Ga. Estimated cost, $18,000.

The Mulberry Explosives and Supply Co. will construct a two-story, 50x120-ft. plant at Mulberry, Fla. Amos H. Norris is Mgr.

An addition will be built to the plant of the Abingdon Mills, Huntsville, Ala.

Wallace Duff, Athens, Tenn., is interested in the organization of a company to be known as the Dixie Highway Tire Co., with $25,000 capital stock, to build a plant for the manufacture of automobile tires.

MIDDLE WEST

It is reported that the American Seamless Tube Co., Martins Ferry, Ohio, will construct a plant near Martins Ferry. Estimated cost, $2,000,000.

The Hawthorn Paper Co. will construct an addition to its plant at Kalamazoo, Mich. Estimated cost, $200,000.

The Riverview Coated Paper Co. will construct a plant at Kalamazoo, Mich. Estimated cost, $400,000.

The contract has been awarded for the construction of a tannery for the Wilder Manning Co. at North Chicago, Ill.

The Central Chemical Co. of Chicago will construct a sulphuric acid plant at Chicago, Ill. Estimated cost, $250,000.

The contract has been awarded for the construction of a five-story plant at Chicago, Ill., for the J. N. Eisendrath Co., manufacturer of gloves and leather goods.

The Cilent Washer Manufacturing Co. has awarded the contract for the construction of a two-story, 35x100-ft. factory at Appleton, Wis.

The Gillette Safety Tire Co. is constructing the first unit of a plant at Eau Claire, Wis. Estimated cost, $20,000. Complete tire manufacturing equipment will be installed at an estimated cost of $30,000. Noted Dec. 23.

Fire, Dec. 12, destroyed the plant of the La Crosse Knitting Works, La Crosse, Wis. Loss, $50,000. E. N. Harrington, Secy.

Fire, Dec. 15, destroyed the factory of the Northwestern Barrel Co., Milwaukee, Wis. Loss, $20,000.

Bids are being received by Herman J. Esser, Arch., 402 Camp Bldg., Milwaukee, Wis., for the construction of factory No. 3 at Milwaukee for the Wyenberg Shoe Manufacturing Co.

Bids will soon be received by Gardner & Lindberg, Arch., 140 South Dearborn St., Chicago, Ill., for the construction of a three-story, 80x120-ft. packing plant at New Richmond, Wis., for the Inter-County Coöperative Packing Co. Estimated cost, $175,00. Noted Nov. 25.

WEST OF THE MISSISSIPPI

The Great Western Sugar Co., Denver, Colo., plans to establish a factory at Belle Fourche, S. D.

The National Flavor Food Products Co., Denver, Colo., contemplates building a factory at Longmont, Colo.

John M. Whitten, Conway, Ark., will rebuild his cotton gin, which was destroyed by fire, at an estimated loss of $4,000.

The Humphrey Tanner Co., Haverhill, Mass., plans to establish a plant at El Paso, Tex.

The Lockhart Oil Mill Co., Lockhart, Tex., will rebuild its cotton seed oil mill recently destroyed by fire. Estimated cost, $50,000.

James R. Armstrong and J. R. Keaton are back of a movement to build an oil refining plant at Newkirk, Okla.

Press reports state that the Interstate Compress Co., Altus, Okla., will rebuild its plant, which was recently destroyed by fire. Estimated cost, $100,000. Noted Nov. 18.

WESTERN STATES

Plans have been prepared for the construction of an addition to the plant of the Hawley Pulp and Paper Co. at Oregon City, Ore. Estimated cost, $500,000. W. P. Hawley, Pres. Noted Dec. 23.

The contract has been awarded for the construction of a packing plant at Colton, Calif., for the Pacific Fruit Express. Estimated cost, $25,000.

We have been advised that work will soon be started on the construction of a seven-story, 100x115-ft. addition to the furniture factory of Peck & Hills, Alpine and San Fernando St., Los Angeles, Calif. Estimated cost, $100,000. Noted Dec. 2.

The Van Vorst & Berman Co., manufacturer of furniture, 1333 East Sixth St., Los Angeles, Calif., has purchased a site at Santa Fé Ave. and 22nd St., Vernon, near Los Angeles, and will construct an 80x200-ft. plant.

CANADA

Fire recently damaged the plant of A. E. Wry, Ltd., manufacturer of harness and saddlery hardware, at Sackville, N. B. Loss, $35,000.

The McLaughlin Carriage Co. will build three-story, 84x225-ft. addition to its plant at Arnprior, Ont. Estimated cost, $500,000. G. H. Johnson, Engr.

The Canadian Duplex Steam Strap Co., Ltd., recently incorporated, will construct a plant at Walkerville, Ont.

The Canadian Connecticut Cotton Mills, Sherbrooke, Que., will build an addition to its plant and install new equipment.

BUSINESS ITEMS

The Crofoot Gear Works, 31 Ames St., Cambridge A Station, Boston, Mass., has bought the New England Gear Works of Boston.

The interests of the Morse Chain Co., Ithaca, N. Y., for the territory including the states of North and South Carolina, will hereafter be taken care of by G. W. Pritchett, with headquarters at 805 Ashboro St., Greensboro, N. C.

TRADE CATALOGS

The Wm. Powell Co., Cincinnati, Ohio. Booklet. White Star Valves. Illustrated, 16 pp., 3½x6 in.

Stow Mfg. Co., Binghamton, N. Y. Bulletin No. 33. Stow flexible grinder. Illustrated, 4 pp., 6x9 in.

Benjamin Electric Mfg. Co., Chicago, Ill. Catalog B-21. Illuminating and wiring devices. Illustrated, 96 pp., 6x9 in.

Armstrong Cark and Insulation Co., Pittsburgh, Penn. Catalog. Nonpariel corkboard insulation. Illustrated, 152 pp., 6x9 in.

Covington Machine Co., Covington, Va. Bulletin No. 11. Covington punches, shears, bending rolls, etc. Illustrated, 12 pp., 8½x10½ in.

Philadelphia Gear Works, 1120-22 Vine St., Philadelphia, Penn. Catalog. Generated spur, bevel and spiral gears, rawhide pinions, etc. Illustrated, 84 pp., 6x9 in.

Newton Machine Tool Works, Inc., Philadelphia, Penn. Catalog No. 50. Rotary planing machines, cold-saw cutting-off machines, cylinder-boring machines, etc. Illustrated, 24 pp., 6x9 in.

PERSONALS

George F. Bartlett, formerly with the Abrasive Material Co., Philadelphia, Penn., has joined the sales division of the Springfield Grinding Co., Springfield, Mass.

Charles S. Dahlquist, until recently chief engineer of the Lippard-Stewart Motor Car Co., Buffalo, N. Y., is now superintendent of the Timken-David Brown Co., Detroit, Mich.

E. E. Neal, who was formerly superintendent of the Smith & Wesson Co., Springfield, Mass., has become works manager of the newly organized Marlin Arms Co., New Haven, Conn.

Joseph C. Regan, formerly assistant general superintendent of the Yale & Towne Manufacturing Co., has been appointed general factory manager of the Timken-Detroit Axle Co., Detroit, Mich.

FORTHCOMING MEETINGS

National Society for the Promotion of Industrial Education. Ninth annual convention, Jan. 20, 21, 22, 1916, Minneapolis, Minn. Alvin E. Dodd, secretary, 140 West 42d St., New York City.

American Society of Mechanical Engineers. Monthly meeting first Tuesday. Calvin W. Rice, secretary, 29 West Thirty-ninth St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting fourth Wednesday each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting second Wednesday of each month. Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. Secretary, R. H. Barnes, Taylor Instrument Companies, Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York, N. Y.

Classified Advertising

Positions Open
Civil Service Work
Employment Agencies
Labor Bureaus

Positions Wanted
Wanted
Agents and Salesmen
Contract Work

Miscellaneous
Educational
Books
For Sale

Business Opportunities

Proposals

RATES: Positions Wanted, 3 cents a word, minimum charge 50 cents an insertion, payable in advance. Other advertisements, 5 cents a word, minimum charge $1.00. Count 4 words for blind address care of our New York or Chicago offices. Advertisements for bids $3.60 an inch.

ANSWERS addressed to us at 10th Ave. and 36th St., New York or 1144 Monadnock Block, Chicago will be forwarded without charge (excepting circulars or similar literature)

IMPORTANT: Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents—send copies. Advertisers' names will not be furnished under any circumstances. Copy received until 10 A.M. Friday for following Thursday's issue.

M

NOTE: Copy for the issue of January 6 is required one day earlier than noted above.

POSITIONS OPEN

Canada

DRAFTSMAN wanted, experienced in induction motor and transformer design. P904—Am. Mach.

DRAFTSMAN wanted, familiar with detailing on induction motors and transformers. P905—Am. Mach.

TWO FIRST CLASS MACHINE SHOP FOREMEN with thorough experience in tooling up and operating a plant for the larger sized high explosive shells. Only men with excellent references covering this class of work need apply. To receive attention, full particulars must be given in the first instance, of experience, by whom previously employed, age and salary expected. P903—Am. Mach.

Connecticut

SEVERAL EXPERIENCED, high-class draftsmen on jig and fixture work. P659--Am. Mach.

TOOLMAKERS wanted, capable of doing first class accurate work on drilling jigs, milling and profiling fixtures and gages for small accurate manufacturing work. P880—Am. Mach.

REAL BONA FIDE experienced tool makers toolroom machine tool hands wanted. High wages on accurate work. No foreman need apply. All letters answered. Electrical Engineering and Storage Battery Co., Sandy Hook, Conn.

Illinois

YOUNG MAN wanted of executive ability in shop management, experienced in precision tool-work; chance for advancement. P865—Am. Mach., Chicago.

Indiana

FIRST CLASS TOOL AND GAGE MAKERS wanted, accustomed to close accurate work. Apply the Stenotype Co., P. O. Box. 814, Indianapolis, Ind.

Massachusetts

DRAFTSMAN with experience on machine tools able to design details of grinding machines from engineers sketches. Steady work under pleasant conditions for right man. State age, experience and pay expected. P851—Am. Mach.

Michigan

TOOL DESIGNERS AND DRAFTSMEN. Experienced men accustomed to jig and fixture work. Also, patent office and body draftsmen. State age, experience, in detail, giving names of employers and dates of entrance and leaving. Also, salary desired. P894—Am. Mach., Chicago.

MAN who is thoroughly familiar with and competent to take charge of a department making shrowds and panels for auto bodies, radiator covers and fenders. Please state present position, how long held, and experience in this particular field. All information will be guarded and kept strictly confidential. P907—Am. Mach., Chicago.

TOOL MAKERS AND ALL AROUND MACHINISTS, accustomed to automobile, jig and fixture work. Good openings near the Great Lakes. Your answer will receive a prompt reply if you state age, whether married or single, names of former employers and dates of entrance and leaving, with salary desired. P895—Am. Mach., Chicago.

WE DESIRE APPLICATIONS for permanent employment from first-class mechanics such as; milling machine hands, turret lathe hands, drill press hands, automatic operators, setters up and tool makers on motors and automobile parts. State where formerly employed, work done in detail, age, and wage expected. Jackson Motor Parts Co., Jackson, Mich.

MAN who is thoroughly familiar with and competent to take charge of a department making rear axle housings. Must know the latest approved methods of welding on this class of work. Please state present position, how long held, and experience in this particular field. All information will be guarded and kept strictly confidential. P906—Am. Mach., Chicago.

GENERAL FOREMAN for small machine shop in Detroit, about 35 men, making automobile parts and doing general manufacturing-machine work; must be first-class workman, capable of producing quantities of work on schedule; no efficiency expert wanted; good opportunity to grow up with small business; state age, nationality and experience fully, also wages desired. P913—Am. Mach.

New York

BOY, 20, with machine-shop experience, for inspector on speed-lathe product; references. P914—Am. Mach.

FOREMAN wanted, in machine shop. Must furnish best of references, and state salary expected. P908—Am. Mach.

OPERATORS on Jones and Lamson, Fellows, and Bilgram generators; planer and lathe hands. New York Gear Works, 56 Greenpoint Ave., Brooklyn, N. Y.

MACHINISTS WANTED: Location, Greater New York. Nine-hour shop. Good openings for capable men as working foreman of milling machines and gear cutters; working foreman of hand screw machines; boring mill operators; tool makers. Applicants must state age, experience in detail and wages expected. P897—Am. Mach.

GENERAL MANAGER wanted for machinery-manufacturing plant; capacity, 75 to 100 men; a high-class man with practical knowledge of office, drawing room, pattern shop, foundry and machine shop, to take entire management of everything from finances to selling; prefer one experienced on pumps, engines or compressors; give full details of experience and salary expected. P867—Am. Mach.

ASSISTANT CHIEF DESIGNER and production superintendent; both of the above positions are open with a large established company who are building a new factory for production of hardened and highly finished steel parts; only men who have had experience with successful manufacturing concerns will be considered; the salaries to start are ample for men of the highest standing and the future prospect of expansion unusually good. P869—Am. Mach.

Ohio

OPERATOR, first class man, for Bullard vertical turret lathe. State age, wage, etc. P879—Am. Mach., Chicago.

MACHINISTS wanted for operating heavy boring mills and other heavy machine tools. State age and experience fully when writing. P850—Am. Mach., Chicago.

MECHANICAL DRAFTSMAN of ability on heavy punching, shearing and forging machinery. State age, salary, experience, full particulars. P854—Am. Mach., Chicago.

A THOROUGHLY capable designing draftsman and checker wanted. Applicant must be steady and reliable. Permanent position to satisfactory man. In replying state age, reference and salary expected. P852—Am. Mach., Chicago.

SEVERAL FIRST-CLASS DRAFTSMEN wanted for electric crane and heavy rolling mill designing. Only those with experience need apply. State age, experience and salary expected. P849—Am. Mach., Chicago.

ASSISTANT TO GENERAL SUPERINTENDENT—If you are a live, energetic mechanic with small-tool experience and executive ability, here is your opportunity; state age, nationality, experience in detail and salary you know you can earn in this capacity. P873—Am. Mach., Chicago.

SUPERINTENDENT WANTED for a machinery plant located in a large city in Ohio; plant equipped with foundry and a thoroughly up-to-date machine shop now employing 300 men. Will pay a good salary to a man with high efficiency and experience. Frank Mossberg, Engineers' Club, 32 W. 40th St., N. Y. City.

Pennsylvania

DRAFTSMAN with experience on general machinery wanted (pumps and hydraulic apparatus). P872—Am. Mach.

FIRST CLASS GRIDLEY SET UP MAN wanted to demonstrate and act as foreman over ten or twelve machines. P859—Am. Mach.

FOREMAN wanted, for machine shop in Central Pennsylvania employing about seventy-five men. State experience, age and furnish references. P881—Am. Mach.

FIRST-CLASS PUNCH AND DIE MAKER wanted, experienced on small work. Must be accurate. State age and reference. Apply to American Metal Works, 314 Armat St., Germantown, Philadelphia, Penn.

THE WESTINGHOUSE ELECTRIC & MFG. CO. are in need of twelve competent men; ones who have had experience on large horizontal boring mills and planers, or ones having had experience on operating lathes, 72 in. and above ,turning large shafts, etc. Address Employment Department, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Utah

EXPERIENCED ENGINEER wanted for assistant in engineering office of large concern engaged in the mining and smelting business—should have first-class technical education and good experience in mechanical work preferably in connection with mining and smelting operations; knowledge of steam and electric power plant design also very desirable; man who is capable of taking charge of office and drafting room is wanted—applicants should give full information in regard to education and experience. P840—Am. Mach., Chicago.

Foreign

TWELVE WORKING SHOP FOREMEN for Russia. Must be experienced in tooling and setting all kinds of American machine tools; a few will be required who have had experience in working sheet metal. P817—Am. Mach.

WANTED FOR IMMEDIATE SERVICE in Milan, Italy, a man thoroughly familiar with the operation of flat turret lathes of the Jones & Lamson, Acme, Potter & Johnston and Pratt & Whitney types, to act as instructor for a period of three to four months; attractive proposition to right man; references required with application. P826—Am. Mach.

Employment Agencies

The Agencies advertising here agree to refund any registration fee on demand any time within the first six months when no position is secured.

H. H. HARRISON & CO., Association Building, Chicago, registers high-grade technical, semi-technical, and shop men only. Unless record can stand investigation when desired, don't reply.

IF AVAILABLE for position as engineer, draftsman, factory executive or educational work in engineering colleges, vocational schools, etc., write us for list of vacancies now open in your line. The Engineering Agency, Inc., 25th year, 1662 Monadnock Block, Chicago.

FIRST-CLASS MACHINISTS, tool makers, die sinkers, lathe, planer, drill press, screw machine, boring and milling machine operators, wood and metal pattern makers, brass polishers, buffers, finishers, millwrights, hammermen and blacksmiths, who wish to increase their opportunities, to register with the free employment department of the National Metal Trades Association, 1021 Peoples Gas Bldg., Chicago, Ill.

CORRESPONDENT

THE UNDERSIGNED plans and conducts correspondence for positions in technical, manufacturing and professional lines for $2500 to $15,000 men exclusively. Complete privacy assured. No commission charged; only service fee and postage. Send name and address only, in confidence, for prefatory details. R. W. Bixby (Established 1910), 81 Niagara Square, Buffalo, N. Y.

POSITIONS WANTED

Connecticut

EXPERT GRINDER, surface and universal, wishes position on tool work requiring special accuracy. PW878—Am. Mach.

I CAN INCREASE your production and improve your product, and tool and die, press work and automatic screw machines. PW884—Am. Mach.

Indiana

A CHIEF TOOL DESIGNER, at present employed, would like to correspond with a live concern which has an opening for such a man as chief tool designer, or assistant superintendent. PW861—Am. Mach., Chicago.

Massachusetts

SUPERINTENDENT, practical, technical, maximum results developing product, systematizing, organizing, manufacturing; day, piece or premium work. PW804—Am. Mach.

Michigan

SUPERINTENDENT OR GENERAL FOREMAN; thorough mechanic, 18 years' experience, proven executive, modern methods, age 37, any desirable location. PW893—Am. Mach., Chicago.

New Jersey

GENERAL FOREMAN; tool, automatic press, hand screw and assembling departments, desires change; practical mechanic, good executive, 15 years on high class interchangeable work. PW890—Am. Mach.

MECHANICAL ENGINEER; have been successful where others have failed in design and superintending construction and development of oil, brass and steam engines, also boilers and ship work; wishes to make a change. PW912—Am. Mach.

SHOP SUPERINTENDENT or general foreman, 35 years, married, A1 inventive mechanic, machinist and toolmaker, technical training, 15 years' practical experience, medium interchangeable work, special knowledge automatic machinery, expert designer of labor-saving devices, resourceful and a good organizer, wishes position with concern in need of a high-grade man who can get results; location immaterial. PW918—Am. Mach.

New York

MECHANICAL DRAFTSMAN wishes position. PW862—Am. Mach.

DIE SINKER, 27, thorough knowledge of die sinking as required by contract-work companies. PW874—Am. Mach.

TOOLROOM FOREMAN, interchangeable works, brass novelties and steel stampings, wishes to change. PW915—Am. Mach.

FOREMAN, tool, die maker, experienced in taking charge manufacturing department; expert in high-explosive shell manufacturing; location immaterial; best of references. PW900—Am. Mach.

EXECUTIVE POSITION; business, selling and shop experience. Special knowledge of steel and heat-treating. University graduate. PW888—Am. Mach.

ENGINEER-DRAFTSMAN, 14 years' varied experience, mechanical, structural, industrial plant construction; wants position as chief draftsman or assistant superintendent. PW838—Am. Mach.

SALES ENGINEER wants to market a high-grade mechanical specialty. Can supply the right kind of energy to produce sales and profits. Broad management experience. PW901—Am. Mach.

TECHNICALLY TRAINED DRAFTSMAN, 29; 5 years' shop, 6 years' drafting room experience, 4 as head draftsman and experimenter, designer of jigs fixtures and special machinery. East or Middle West preferred. PW882—Am. Mach.

THOROUGH MECHANIC AND TOOLMAKER, well acquainted with manufacture of motion picture and similar small machinery, used to handling help, desires responsible position with growing concern. PW886—Am. Mach.

POWER PLANT ENGINEER OR ASSISTANT; licensed man; thoroughly understanding through experience, the care and operation of engines, boilers and auxiliary equipment; immediately available; location immaterial. PW—750Am. Mach.

FOREMAN, with ten years' experience on automatic machines; wishes to connect with some reliable concern. Can design cams, tools, etc., for Brown & Sharpe, Cleveland, Acme and Gridley machines. Large and small work. PW809—Am. Mach.

FOREMAN, toolroom or manufacturing department, 19 years' experience, tool and machine work, 9½ years toolroom foreman. Can design and make tools for or take charge of hand or automatic screw machine, also fuses, gage, time, etc. PW883—Am. Mach.

PRACTICAL ENGINEER of wide experience desires responsible executive position; technical graduate with shop, drafting room and sales engineering experience; thorough knowledge of machine tools, ordnance designs and special machines. PW911—Am. Mach.

AS SUPERINTENDENT or chief draftsman by mechanical engineer, designer of special and automatic machinery, power presses and dies for working sheet metal, both light and heavy. Highest ability, long experience and thoroughly practical. PW899—Am. Mach.

PATTERNMAKER seeks responsible position, 25 years' practical experience on general machine work. Engines, electric equipment, light and heavy (best methods for production) reliable references, 5 years with present employers, age 40. PW889—Am. Mach.

HEAT-TREATER AND CARBONIZER; expert, wide experience up-to-date knowledge. Technical education. Experienced in the use of modern equipment, including testing machines. Capable of taking complete charge of heat-treating department. PW887—Am. Mach.

SUPERINTENDENT, assistant or general foreman—Man, 33, with thorough practical experience in the above capacities on the rapid production of small interchangeable parts such as building hardware, small arms, light machinery, instruments, etc., is open to immediate engagement. PW910—Am. Mach.

PRODUCTION SUPERINTENDENT or assistant superintendent, a practical mechanic with exceptional training and abilities, experienced on tool and jig design, routing interchangeable manufacture, etc., good education and a thorough efficient executive, wishes to make a change; prefers Eastern states. PW916—Am. Mach.

FACTORY MANAGER: Engineering graduate, age 31, married, 9 years' thorough manufacturing experience, including shop apprenticeship, sales, correspondence, organizing, cost and production departments, and operating large factory as works manager, where now employed. Work effective in handling men, lowering costs, increasing production and efficiency, and maintaining first quality work. Salary, $4,000. Open to engagement after January first. Immediate correspondence solicited. PW885—Am. Mach.

Ohio

AS SUPERINTENDENT OR MANAGER. Good mechanic and executive, competent to organize, and operate so results may be obtained at a minimum cost. PW687—Am. Mach., Chicago.

AS MANAGER OR GENERAL SUPERINTENDENT by a practical man of wide and successful experience in the supervision and management of manufacturing plants consisting of machine shop, foundries, etc. Always maintained open shop conditions with unquestioned control by the management in all directions; at present employed, but would prefer a change with opportunity to take a position on commission instead of salary. PW822—Am. Mach.

Pennsylvania

AS SUPERINTENDENT OR MECHANICAL ENGINEER, by competent, original designer and constructor of steam engines, gasoline motors, motor trucks and general machinery. Excellent mechanical and executive ability. References; now employed. PW891—Am. Mach.

WANTED

SMALL FACTORY, well equipped, good railway facilities, is desirous of getting hold of small tools to manufacture on a royalty basis or buy outright. W813—Am. Mach.

AGENTS AND SALESMEN

A GOOD MAN in each shop to sell sliding calipers and round levels; liberal commission. Ernst G. Smith, Tampa, Fla.

AGENT at present representing two well known tool manufacturers in New York and vicinity; and calling on practically all machine shops of any size would like to secure other good lines. Address J. A. P. 207 E. 16th St., New York.

SALES AGENT (engineer) having established office (8 years) and large acquaintance with power users in New York territory, would make new connection on salary basis with reputable firm, or consider several accounts on commission. W896—Am. Mach.

CONTRACT WORK

PUNCH PRESS TOOLS, jigs, fixtures, etc. Taylor-Shantz Co., Rochester, N. Y.

MACHINE WORK wanted, small and medium size; patterns, models, etc. J. D. Wallace, 527 W. Van Buren St., Chicago.

WANTED—Die sinking; we also make blanking, trimming and forming dies. South Bend Die and Tool Co., South Bend, Ind.

WORK WANTED on worms, worm gears, spiral gears and spur gears up to 14 in. diam. Ten years' experience in this line. Pullman-Field Machine Co., Sodus, N. Y.

JIGS, FIXTURES AND SPECIAL MACHINERY of all kinds designed by experts. Let us do your drafting. Send sample or drawing for estimate. Terms reasonable. W853—Am. Mach.

MACHINERY, small or medium, designing, models, dies or jigs, 1 to 1000 or more, right to your B/P's. Estimates submitted. Berggren and Pearson Machine Co., 221-227 Canal St., New York City.

WORK WANTED. Have available 9 wood-tilted turret lathes taking 1-inch bar, 3 wood-tilted turret lathes taking ¾-inch bar, 1 Hartford automatic screw machine taking ¾-inch bar and several two- and three-spindle drill presses. Eclipse Machine Tool Co., 62 Sudbury St., Boston, Mass.

WE OFFER the manufacturing facilities of our new fireproof factory, equipped with electrically driven modern machine tools and wood-working machinery; located 100 miles from New York City; transportation via New York Central and Boston & Albany railroads and Hudson River; private siding; sale of part interest in factory considered. W460—Am. Mach.

CONTRACTS TO BE LET

WANTED MANUFACTURERS of automatic screw machine products, steel and brass sizes ⅛ to 3 inches; we purchase large quantities for our regular work, have no war business. W779—Am. Mach.

BUSINESS OPPORTUNITIES

WOULD LIKE TO CONSIDER MANAGEMENT, with option of purchasing at a future time, of a moderate size machine shop, equipped and located for manufacturing machine tools later. BO917—Am. Mach.

INVESTOR wants a mechanical specialty capable of wide application in manufacturing trades. Will buy business outright, or on partnership basis. Submit description of product with present state of development. Best references. BO902—Am. Mach.

FOR SALE; an established business comprising the manufacture and sale of a widely used standard tool, fully covered by patents. Complete and exceptionally fine equipment of jigs, fixtures, tools and gauges for manufacturing. Largest corporations in country regular customers. Personal reasons for selling. Address Lock Box 1023, Detroit, Mich.

MACHINERY MANUFACTURING business located in the Middle West, established 4 years, fully equipped, machines patented, very little competition, business has been built up from profits. Reason for sale, sole owner desires to devote entire time to other interests, would sell part interest to party capable of managing without assistance of owner. This is a sound business proposition and will bear close investigation. BO814—Am. Mach., Chicago.

MACHINE SHOP FOR SALE; 300 medium sized tools (75 lathes 10 to 20" swing) in full operation; 55,000 sq.ft. of floor space; large lot, fully equipped to finish 2000-3" shrapnel per day; price $400,000. Plants, sites, space in all sections, all sizes, with and without water and rail facilities. Send specifications of your requirements and desired location of the same. We handle above exclusively from an engineering and manufacturing standpoint. J. Alan Middleton, Factory Specialist, 609-11 Widener Bldg., Philadelphia.

MISCELLANEOUS

GET A "LAST WORD," the Test Indicator Par Excellence. Described in Nov. 18 issue, American Machinist. H. A. Lowe, 1374 E. 88th St., Cleveland, Ohio.

$1 BRINGS THE CORRECT ANSWER to any practical or scientific question on electric welding, or money refunded. General Welding Supplies Co., Westfield, N. J.

PATENT ATTORNEYS

PATENTS. C. L. Parker, patent attorney, McGill Bldg., Washington, D. C. Inventor's handbook sent upon request.

FOR SALE

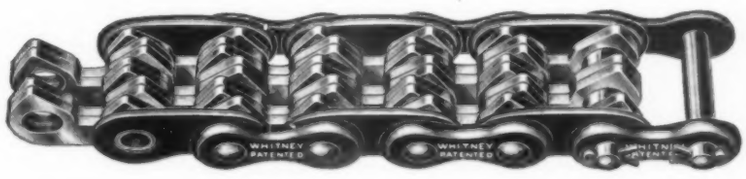
TWO AND ONE-HALF and three feet radial drill patterns, jigs and templets. FS810—Am. Mach., Chicago.

CAMDEN, N. J., immediate occupancy, suitable for war orders or any business; brick buildings, 93,000 feet of floor space, with very fine power plant; 4.6 acres on water front, Philadelphia lighterage limits; price a decided bargain; substantial mortgage. L. N. Creighton, Agent, Bayonne, N. J.

Additional Want and For Sale Advertisements and Advertising of Second-Hand Machinery appears on pages 158, 159, 160 and 161

Where Belts Are Inefficient

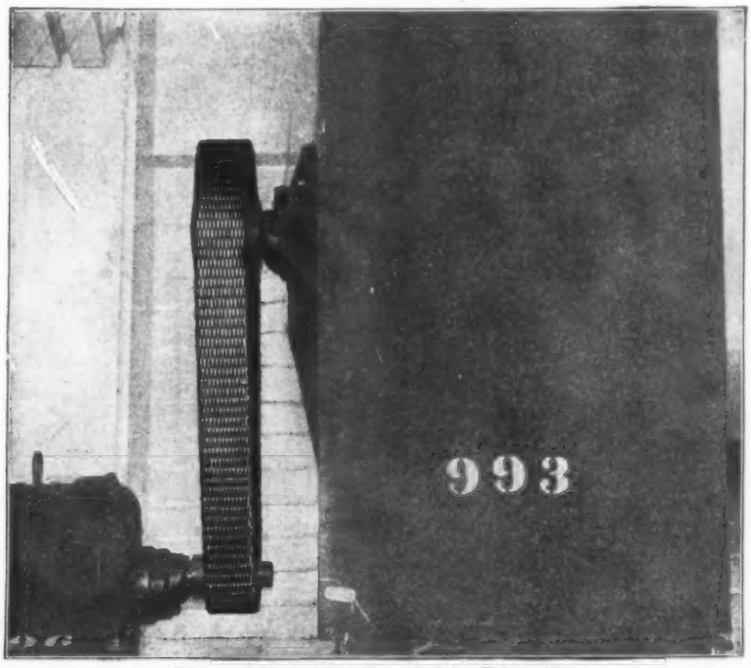
On these short drives between motors and fans, and between motors and machines, where there's considerable difference betweer diameter of the respective wheels, belts are no good at all. This is the place for



"WHITNEY" CHAINS

Silent Type

which have a certain desirable flexibility like belts, but give a positive connection like gears. Cost a little more to begin with—but last longer to end with.



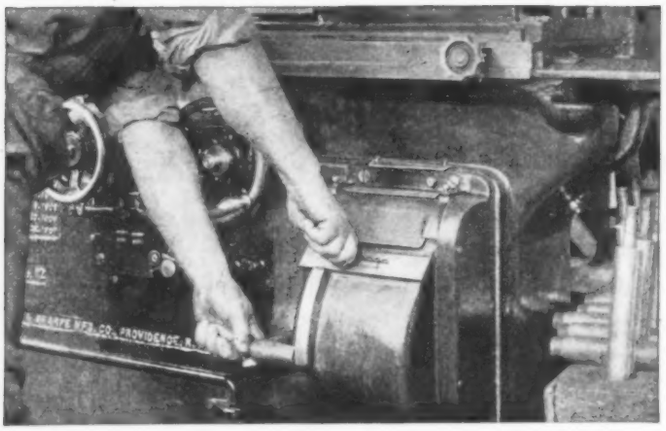
"Whitney" Chain, Silent Type, Driving Exhaust Fan

It will pay you to investigate.

Ask for fully illustrated descriptive literature.

The Whitney Mfg. Co., Hartford Conn.

Chains—Keys—Hand Milling Machines



Making an Efficient Start on the Job—Getting the Right Speeds and Feeds

Both mean substantially the same thing. If you want to get the best possible production, the combination of speed and feed *must* be right. Can an operator get that combination? How long does it take him to get it? Those are two important questions that are efficiently answered in the design of Brown & Sharpe Plain Grinding Machines.

The picture above shows an operator adjusting the rate of table traverse on one of our larger machines. Through an independent gear-driven change mechanism he is able to get the required feed *at once*. No time is lost. With the left hand he drops the lever, with the right hand he moves the index knob to the required position and pulling the lever back into position with the left hand he has the correct feed. By turning to a similar mechanism on the other side of the machine bed he adjusts the work speed in the same easy manner. It is the work of a few seconds in each case.

Think what this means in time saved in setting up. Its biggest advantage, however, is the fact that the most productive combination of speed and feed is available *instantly*.

A Single Back Rest that Gives Proper Support For All Work

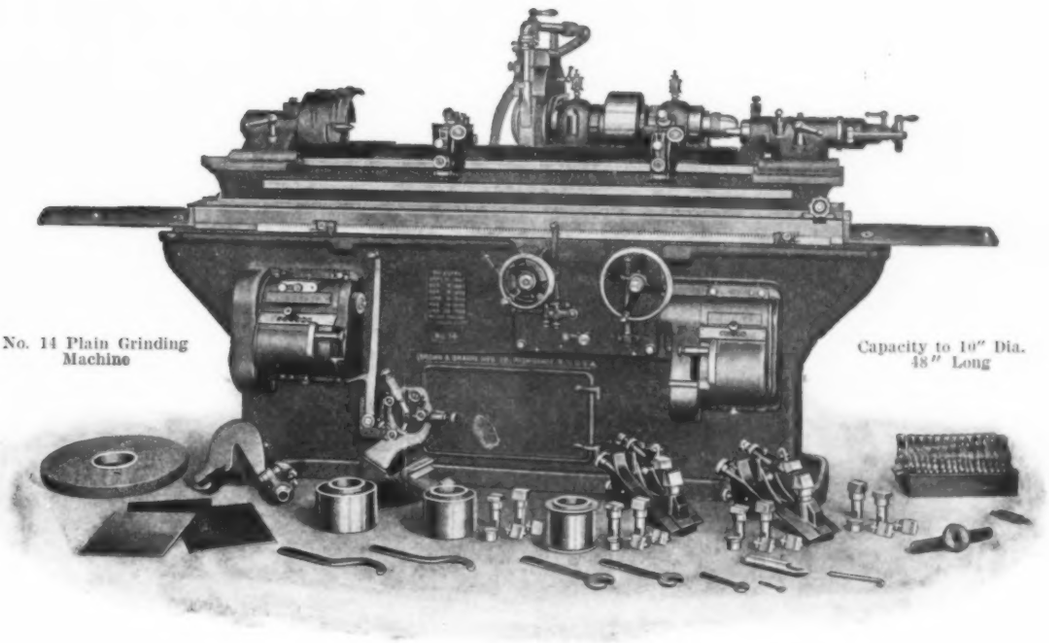
Adequate support for work being ground is essential if accuracy and fast production are required. When work is properly supported it can be ground true and parallel under much heavier cuts. Brown & Sharpe Combination Plain and Universal Back Rests offer an important advantage in that they are designed to furnish just the right degree of support for all work within the capacity of the machine.

For long, slender work they are capable of the same delicate adjustments as our regular Universal Back Rests, automatically exerting the proper degree of pressure against the work to offset the springing tendency until the piece is reduced to size. For work of medium size and weight requiring a little stiffer support the Combination Rest can be adjusted as a semi-universal rest. For heavy work it can be used as a solid rest giving very rigid support.

The advantages of back rests of this kind are worth considering. They are handy and efficient, they help to secure more accurate results and increase the productiveness of the machine.

Brown & Sharpe Mfg. Co., P

OFFICES: 20 Vesey St., New York, N. Y.; 654 The Bourse, Philadelphia, Penn.; 626-630 Washington Blvd., Chicago, Ill.; 305 Chamber of Commerce Bldg., Rochester, N. Y.; Room 419, University Block, Syracuse, N. Y.
REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Penn., Erie, Penn.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O., Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Calif.; Strong, Carlisle & Hammond Co., Cleveland, O., Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore.



No. 14 Plain Grinding Machine

Capacity to 10″ Dia. 48″ Long

The B. & S. Way: Easy Operation—Fast Production—Profitable Results

Those are the conditions a far-seeing shop executive seeks. He looks for them because they are not only profitable to him but also satisfactory to the men in the shop. An operator is well satisfied and will maintain a high standard for quality and production in his work if he has a machine with which he can secure the desired results with normal effort. A production man is satisfied when he has machines that turn out good work at a rate he knows to be profitable and satisfactory.

The Brown & Sharpe No. 14 Plain Grinding Machine, shown above, meets requirements from every standpoint. Efficiently designed, solidly constructed and finished with extreme care, it is easily and quickly set up and handy to operate; it produces accurate, well-finished work at a maximum rate.

Besides being equipped with the independent gear-driven change mechanisms, and the combination Back Rests this machine has an Automatic Cross Feed that can be set to reduce pieces to a definite size and automatically disengage. This means no attention from the operator while the work is being ground, thus enabling him to prepare work or run another machine. Other operating conveniences and production features on this machine are worth your careful attention. They are fully described in our special circulars. Send for one.

A Handy Booklet on the Selection of Grinding Wheels—Free

Do you know how to select wheels for the different jobs you handle? Our booklet "Points About Grinding Wheels and Their Selection" contains much information along these lines. It describes the characteristics of different abrasives and their grading, bonding and suitability to various types of work. Every grinding machine operator should have a copy. A postal brings you one—free.

Providence, R. I., U. S. A.

Canadian Agents: The Canadian-Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. John, Saskatoon.
Foreign Agents: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow. F. G. Kretschmer & Co., Frankfort a.M., Germany V. Lowener, Copenhagen, Denmark, Stokcholm, Sweden, Christiania, Norway; Schuchardt & Schutte, Petrograd, Russia; Fenwick, Freres & Co., Paris, France; Liege, Belgium; Turin, Italy; Zurich, Switzerland; Barcelona, Spain; F. W. Horne, Tokio, Japan; L. A. Vail, Melbourne, Australia; F. L. Strong, Manila, P. I.

READ NEXT PAGE

Handy and Serviceable Tools for Laying Out Fine Work

are a necessary part of a machinist's or tool maker's kit. In laying out fine work handy, well made and serviceably designed tools are demanded by the careful mechanic. Here are a few tools from the Brown & Sharpe line that amply meet the most exacting demands. They are designed with practical requirements in view, are well made to withstand hard service and finished with the care that characterizes all

Brown & Sharpe Tools

The B. & S. Tool Makers' Dividers are made with a hardened fulcrum stud. The spring is unusually stiff and so made as to prevent side deflection. The points of the legs come evenly together when closed. The Firm Joint Hermaphrodite Calipers are handy, serviceable and dependable, the adjustable point greatly increasing its handiness and economy.

The B. & S. Automatic Center Punch is an efficient substitute for the ordinary center punch and hammer. The points can be removed for grinding and are easily replaced if broken. The Tool Makers' Clamps are designed to give strength and rigidity. A handy feature is the spring attachment which prevents the loose jaw from dropping or slipping.

The B. & S. Tool Maker's Vise is handy for drilling and fitting small pieces. Drop forged and case hardened it is well adapted to hard usage, and is convenient to handle. B. & S. Scribers are made with finely tempered tool steel points that are threaded to screw into the holder.

All of these handy tools should be in your kit. They are carried in stock by leading hardware dealers and are listed in our No. 26 catalog. Have you a copy?

Brown & Sharpe Mfg. Co.

Providence, R. I., U. S. A.

THE BANNER OF MERIT

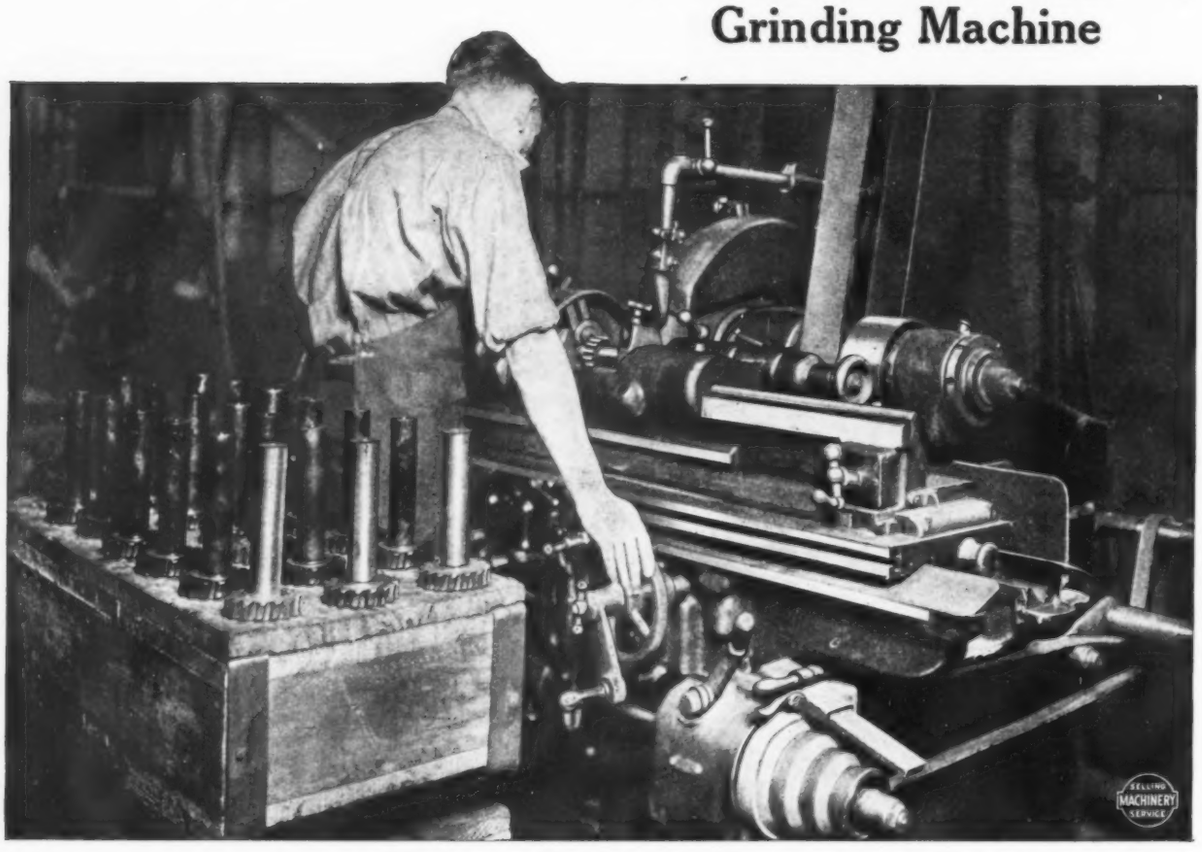
SHOWING THE OFFICIAL AWARD RIBBON OF THE MEDAL OF HONOR AWARDED TRIMO TOOLS AT THE PANAMA-PACIFIC INTERNATIONAL EXPOSITION

HONOR AWARDED MEANS MERIT REWARDED

Nut with Nut-Guards

SEND FOR CATALOG No. 75

400 Shafts and Shoulders in 10 Hours on a NORTON Grinding Machine



If you are doing roughing or finishing in a lathe, these figures will be interesting—and may open your eyes! This record is not a sprint, stunt or stampede—simply an every day, all day, steady jog with the Gemmer Mfg. Co., Detroit.

The subject shown is part of an automobile steering worm mechanism. Shaft is $5\frac{1}{2}''$ long, $1\frac{1}{8}''$ diameter. Carries 8 shoulder 2″ diameter by $\frac{3}{8}''$ wide which must be at right angles to the shaft. The limit is very close. Production is 400 in 10 hours.

Do you know the Norton Grinding Machine in very many shops is superceding **both roughing** and **finishing** on the lathe? Doing the work in less time, with less labor and greater ease in handling! The finished result admits of no comparison.

The advantages of Norton Grinding Machines are past enumeration here. If you will just write us we'll go into the subject as far as you like.

NORTON GRINDING COMPANY

Worcester - - - - Mass.

Chicago Store, 11 N. Jefferson Street

Vonnegut Machinery Company, Indianapolis, Ind. **Robinson, Cary & Sands Company**, St. Paul and Duluth, Minn. **Manning, Maxwell & Moore, Inc.**, St. Louis, Mo. **Prentiss Tool & Supply Company**, New York, N. Y.; Boston, Mass.; Buffalo, N. Y.; Rochester, N. Y.; Syracuse, N. Y.; Scranton, Pa. **The Motch & Merryweather Machinery Company**, Cleveland, O.; Detroit, Mich.; Pittsburgh, Pa.; Cincinnati, O. **Eccles & Smith Company**, San Francisco, Cal.; Los Angeles, Cal.; Portland, Ore. **The Canadian Fairbanks-Morse Company, Ltd.**, Montreal, Que.; Toronto, Ont.; Vancouver, B. C. **C. T. Patterson Company, Ltd.**, New Orleans, La. **Kemp Machinery Company**, Baltimore, Md. **W. E. Shipley Machinery Company**, Philadelphia, Pa. **Alfred Herbert, Ltd.**, Coventry, Eng.; Paris, France; Milan, Italy. **Schuchardt & Schutte**, Vienna, Austria; Prague, Austria; Budapest, Austria; Stockholm, Sweden. **Post Van der Burg and Company**, Rotterdam, Holland. **The F. W. Horne Company**, Tokio, Japan.

Alundum
TRADE MARK REGISTERED

Crystolon
TRADE MARK REGISTERED

Experience and Science produce Results

¶Experience is a vital factor in determining the correct wheel to meet existing conditions—or in correcting the conditions. Correct conditions mean greater profits.

Science has been the vital factor in the development of Norton Alundum and Norton Crystolon and in the perfecting of the manufacturing processes that are largely responsible for the quality of

Norton Grinding Wheels

Results that take the form of larger production—lower operating cost—better finish—constitute the substance of reports upon the performance of Norton wheels from foundries and machine shops everywhere.

If you have a grinding problem there is abundant reason why you should inquire if Norton experience can aid in its solution.

You have only to write

Norton Company
Worcester, Mass., U.S.A.

New York Store
151 Chambers Street

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11 North Jefferson Street

Electric Furnace Plants
Niagara Falls, N.Y.; Chippawa, Ont., Can.

686

UNI

"The Tools You Buy Again"

Let the name "Union" sink deep. For when applied to Milling Cutters it means many things for which you are on the lookout.

It means cutters that in type are exactly suited to the work—that stand up—that cut fast and clean—that require less regrindings. All of these claims can be proved by a trial.

Get the right type of cutter for the purpose, see that it bears the name "Union"—then drive straight ahead for complete satisfaction.

UNION TWIST DRILL COMPANY

The Drill and Cutter Makers **Athol, Mass., U. S. A.**

New York Store: 62 Reade St., E. W. McKeen. Philadelphia Store: 43 North 7th St., H. L. Morrison, Mgr. Chicago Store: 11 So. Clinton St., W. G. Lunger, Mgr. Kansas City, Mo.: 310 Delaware St., Mr. A. L. Richtmyre. Southern Representatives: Messrs. Pasco & Tull, 522 Candler Bldg., Atlanta, Ga. Detroit: 56 Cadillac Square, H. B. Kendall, Mgr.

MILLING

ON

This is a High-Speed Steel Special Shell End Mill, one of the "High-Power Cutters" which a man who knows, said, marks the only radical improvement in milling cutters in years.

The "Book of Information" contains a quantity of valuable data for the user of cutters. It will be sent you for the asking if you state name, address and position occupied.

CUTTERS

Heavier Feeds—Fast Speeds on SKF Self-Aligning Ball Bearing

Over in the Ward Motor Vehicle Co.'s plant, in Mount Vernon, N. Y., there's a 24" Greaves-Klusman Lathe working on cast iron jig plates.

For ease of operation on a lathe of this size its owners consider it a wonder.

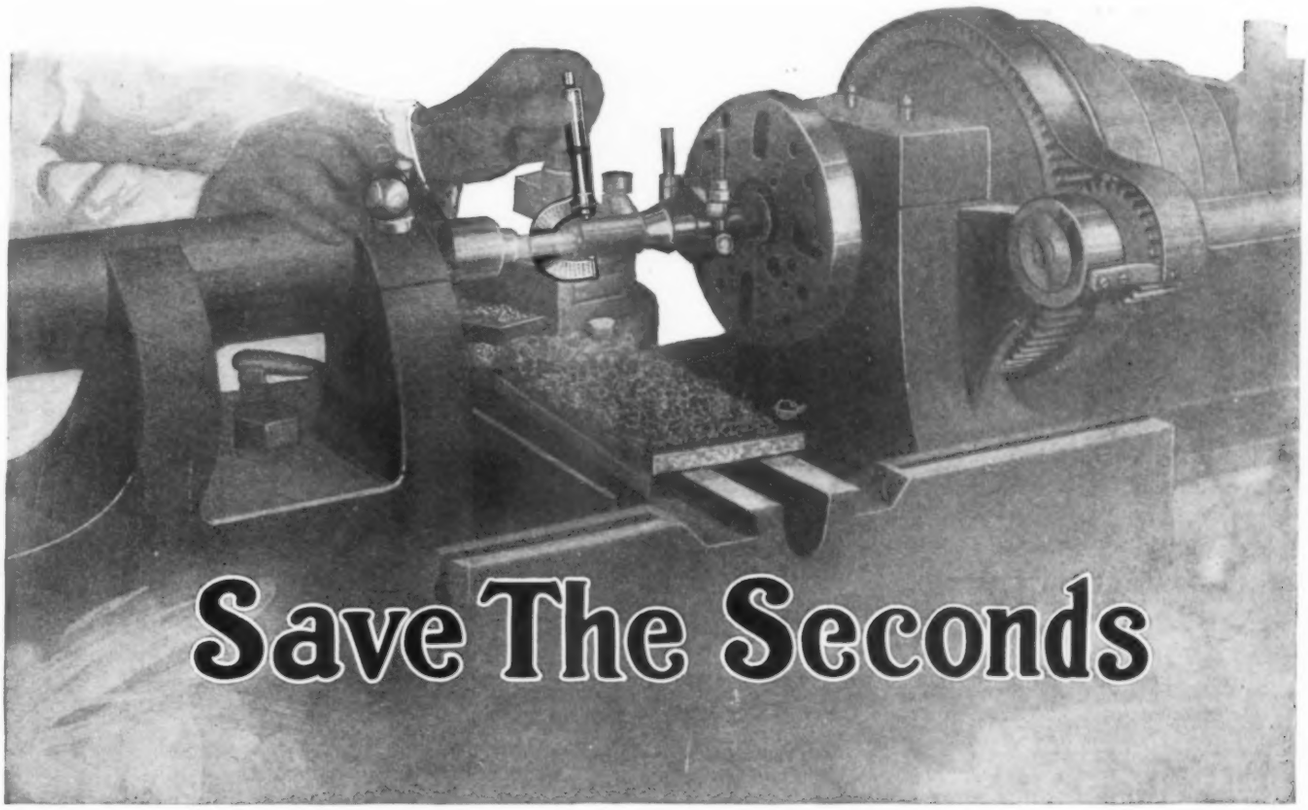
SKF Ball Bearings are used—naturally. And, to use the exact words of the Ward Motor Vehicle Co., ***"The ball bearings take care of themselves."***

This ability to "take care of themselves" is an advantage which **SKF Ball Bearings** possess to the nth degree. They are trouble-proof, insure more power to the cut, permit heavier cuts, heavier feeds and greater speeds. Made of Swedish Crucible Steel.

Write and let us send you Bulletin No. 25, entitled "Ball Bearings in Machine Tools and Shop Equipments." This is a treatise worth having.

SKF BALL BEARING CO.
50 Church Street, New York City

One of the 24" Greaves-Klusman Lathes equipped with SKF Ball Bearings.



Save The Seconds

WHETHER you are a machinist, a foreman, a superintendent, an engineer or a manufacturer, your success depends largely on seconds saved.

Starrett Tools

and Instruments of Precision

are designed to save time. For example, the Starrett Quick Adjusting Micrometer can be instantly opened or closed to any point ready for the fine adjustment.

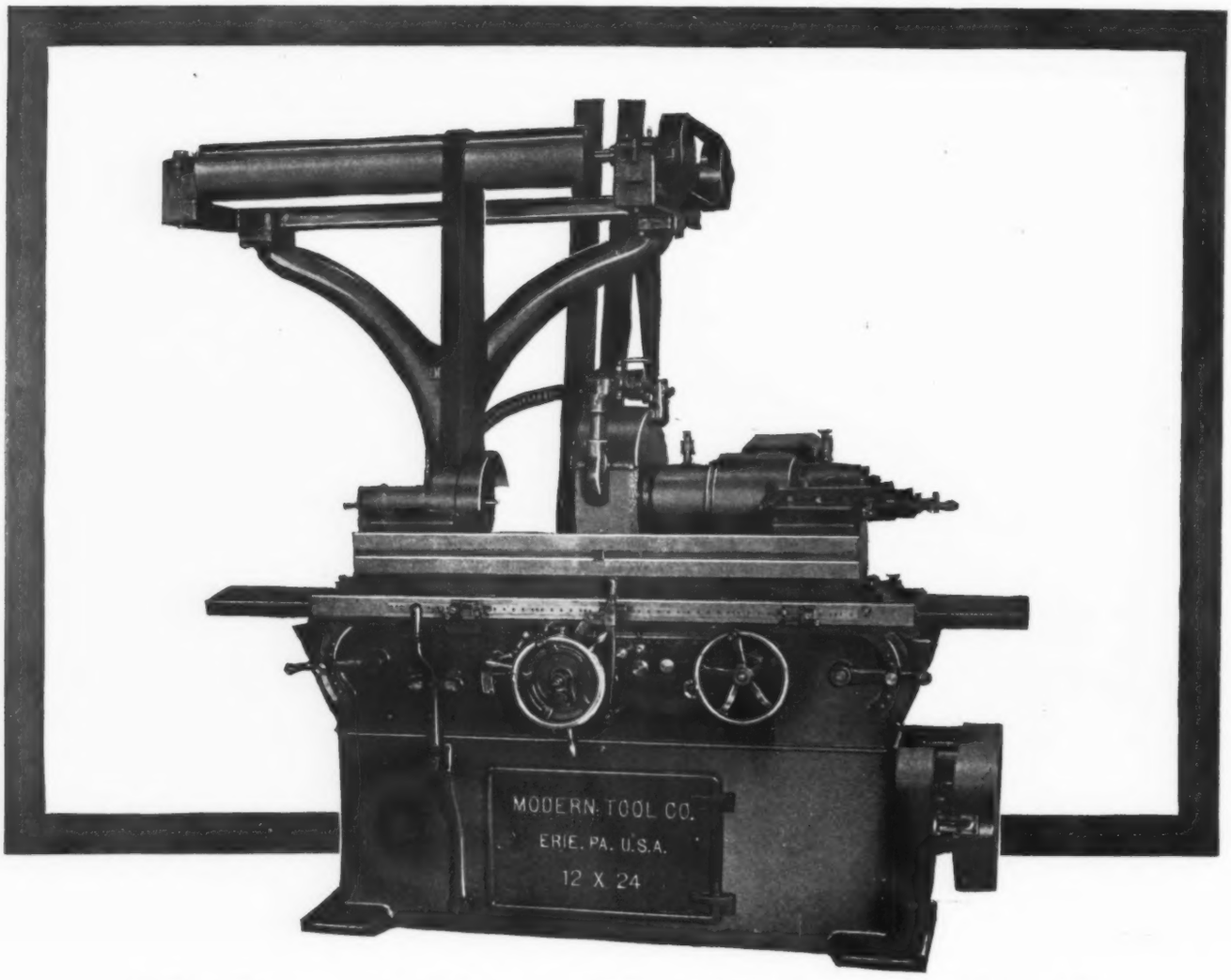
Other Starrett Tools are vernier calipers, combination squares, steel tapes and rules, dividers, hack saws, wrench sets, screwdrivers, expansion pliers.

Send for Free Catalog No. 20-C

THE L. S. STARRETT CO., ATHOL, MASS.

"The World's Greatest Tool Makers"

New York **London** **Chicago**



Modern 12" x 24" Self-Contained Grinding Machine—

This is a powerful, rigid and effective machine that will give you an extra measure of shell production.

Large diameter, wide face wheel with powerful drive.

Automatic feed, without traversing the table, where required.

Absolute central control of all levers and hand wheels.

Single constant speed drive.

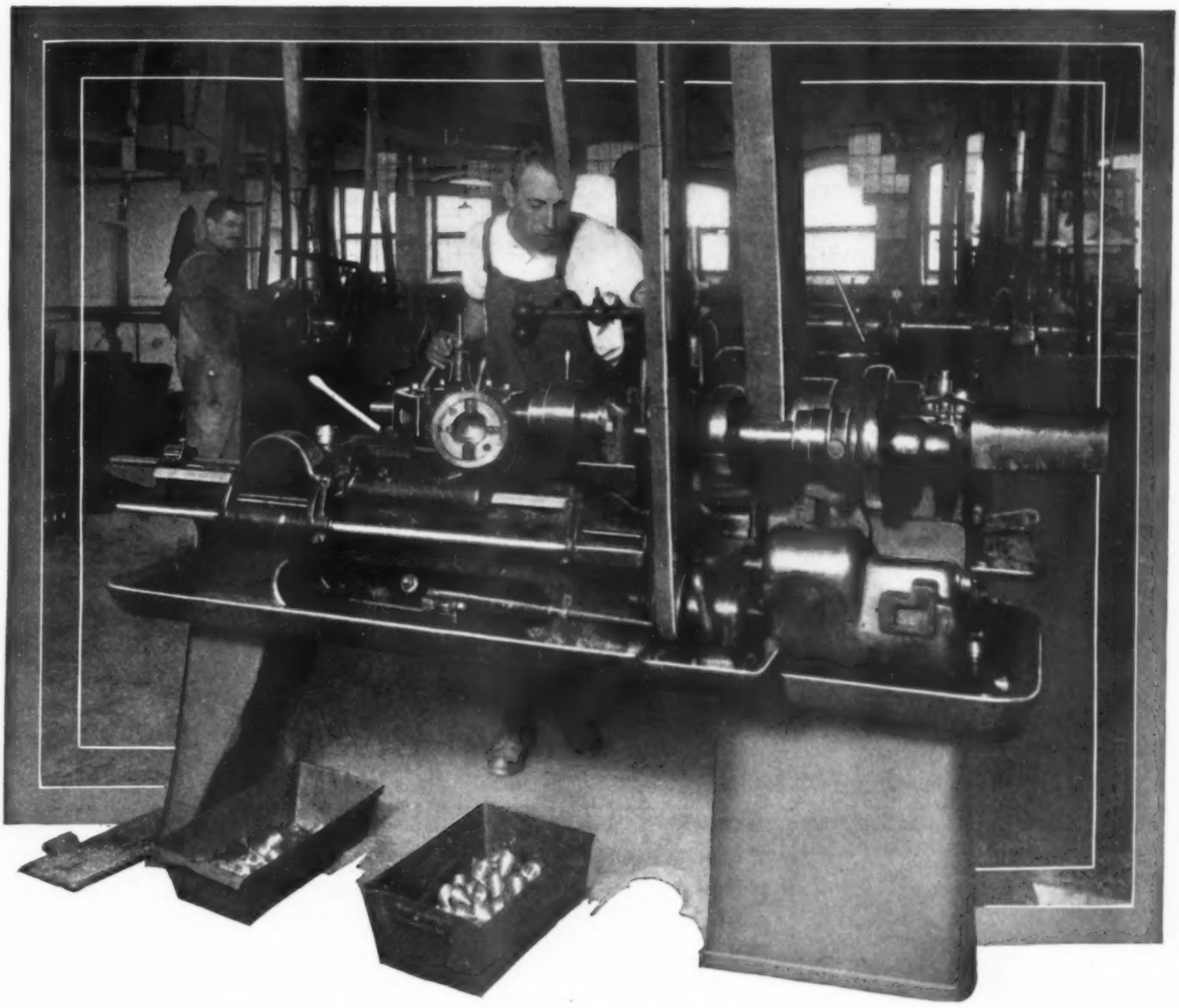
Write for full details.

USED BY A LARGE NUMBER OF SHELL MAKERS IN UNITED STATES AND CANADA.

It comes equipped for all classes of straight and taper cylindrical work.
Send for blueprints and estimates.

MODERN TOOL COMPANY

Chicago Office: 32 N. Clinton Street. **For Canada: Rudel-Belnap Machinery Co., Toronto and Montreal.**



Modern Die-Heads Cut the Outside Threads on Shell Fuses

The photograph, taken at the Providence Engineering Works, Providence, R.I., shows an outside thread being cut on a Shell Fuse. This is a difficult operation that is being very satisfactorily handled by the company with the use of MODERN DIE HEADS. Two die-heads are used; the first for a heavy roughing cut and the latter for a very fine finishing cut close up to the shoulder.

"We have found Modern dies very satisfactory in this service. They are well made, both in regard to design and workmanship. The chasers stand up well. We have appreciated the very prompt service that the Modern Tool Company has given us," writes Mr. W. P. Alexander of the Providence Engineering Works.

Are you interested in Die-Heads for Shell Work and other operations? Do you appreciate prompt service? Are you looking for a high-quality article that gives entire satisfaction?

If so, get in touch with us. Write for complete details.

ERIE, PENN., U. S. A.

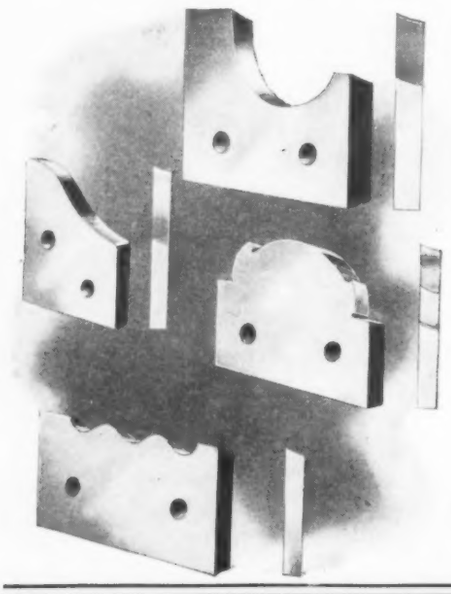
Main Office and Works: Fourth and Main Streets

This grinding was not expensive—

It was performed, at a minimum amount of time and cost, by the

Fischer Profile Grinding Machine

Here's a machine, capable of grinding irregular-formed turning tools such as used in the machining of tire moulds, car wheels, etc—*economically*.



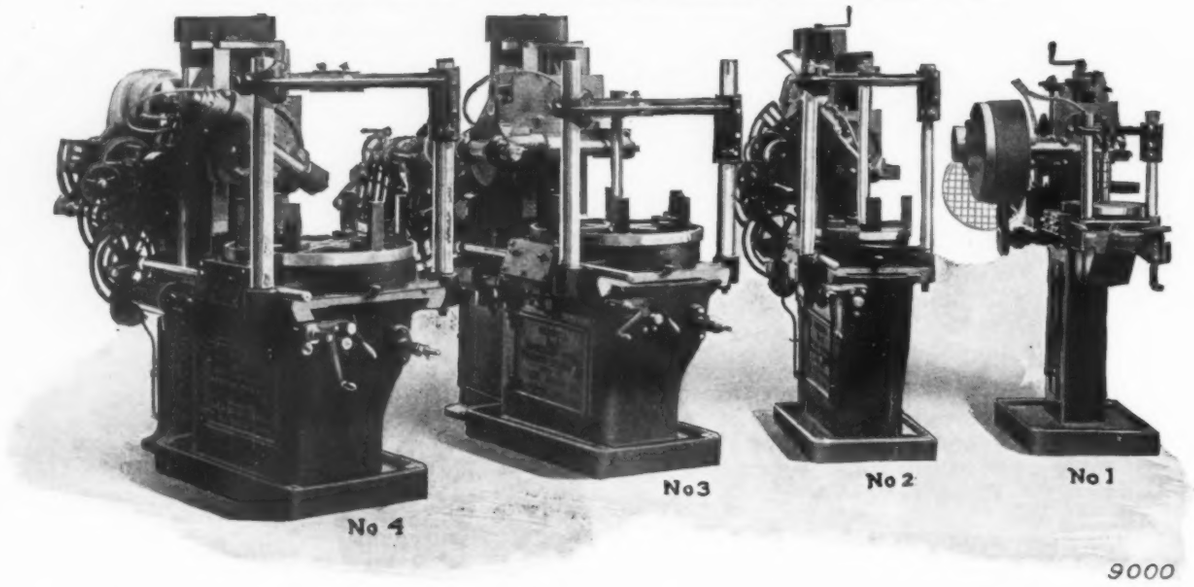
After watching your first-class tool maker take from one to five days on a similar job, perhaps you will not think this possible.

But it is—and you will appreciate it after you have read about it. The description of the grinder-head and the operation of the machine, is included in the circular.

Write for a copy now.

Fischer Machine Co., 310-316 No. 11th St.
Philadelphia, Pa.

A MOST COMPLETE LINE



Both Plain and Spiral Gear Hobbers. The kind that give satisfaction every time.

Nos. 1 and 3 are Plain Gear Hobbers, built to cut Spur Gears and Worm Wheels. Capacity, 14″ and 35″ respectively.

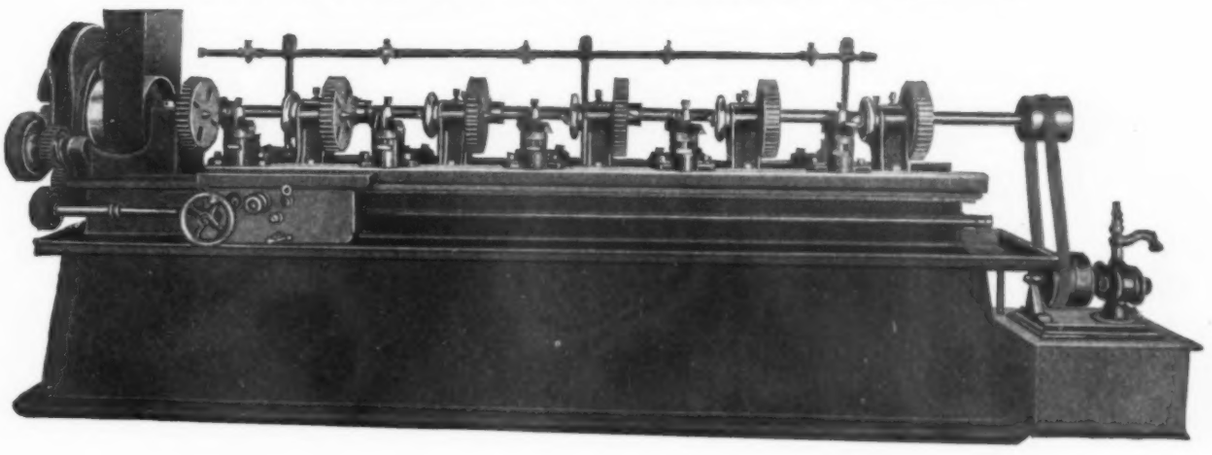
Nos. 2 and 4 are Spiral Gear Hobbers, built to cut Spiral Gears and Worms as well as Spur Gears and Worm Wheels. Capacity, 22″ and 35″ respectively.

Write for catalogue No. 806.

THE ADAMS CO., 1912 Bridge Street, Dubuque, Iowa

You Can Rough Turn Five Shells Simultaneously

How? By using this remarkable new machine



CHERNACK-MULTIPLE-LATHE

This new and original machine has just been placed on the market. It revolutionizes the speed of rough turning of shells, shafts, automobile parts and similar work. It will do the work of three ordinary lathes.

It turns up to 5 pieces simultaneously, depending on the length. **Will rough turn five 3″ shells, four 4½″ or three 6″ shells at the same time.**

Both head and tail stock centers are revolving with the work and in this way the operator is relieved from oiling them.

This machine will cut your turning costs tremendously. Write NOW for complete details. This machine is a winner.

Jenckes Knitting Machine Co.

Pawtucket, R. I.

'Most every plant has some line and countershafting

Why not drive yours by electric Motors through MORSE Silent Chains?

THE transmission of power to line and countershafting IN ANY PLANT is a problem of mechanics rather than individual shop conditions.

A certain sustained speed is desired, easily obtainable by MORSE Silent Chain reduction from practically any speed motor. The motor can be of the standard high-speed type which cost less than special slow speed motors, and, it can be mounted close to the shafting, on the wall, ceiling, or a column, thus saving floor space.

MORSE Silent Chain transmission requires less lubrication than gearing and usually less attention than belting.

It is more efficient than either gearing or belting, and is much more quiet than gearing.

It is not affected by heat, cold, or moisture, and minimizes fire risks by eliminating dangerous sparking.

If you have not yet received copies of the late publications mentioned opposite, write for them today.

Ask nearest office for free copies of our publications, No. 13, Textile Mills, No. 14, Large Power Drives, the first two in our series "A CHAIN OF EVIDENCE."

W-11

Morse Chain Company, General Office and Works, **Ithaca, N. Y.**

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BOSTON, 141 Milk Street.
CHICAGO, Merchants L. & T. Building.
PITTSBURGH, Westinghouse Building.
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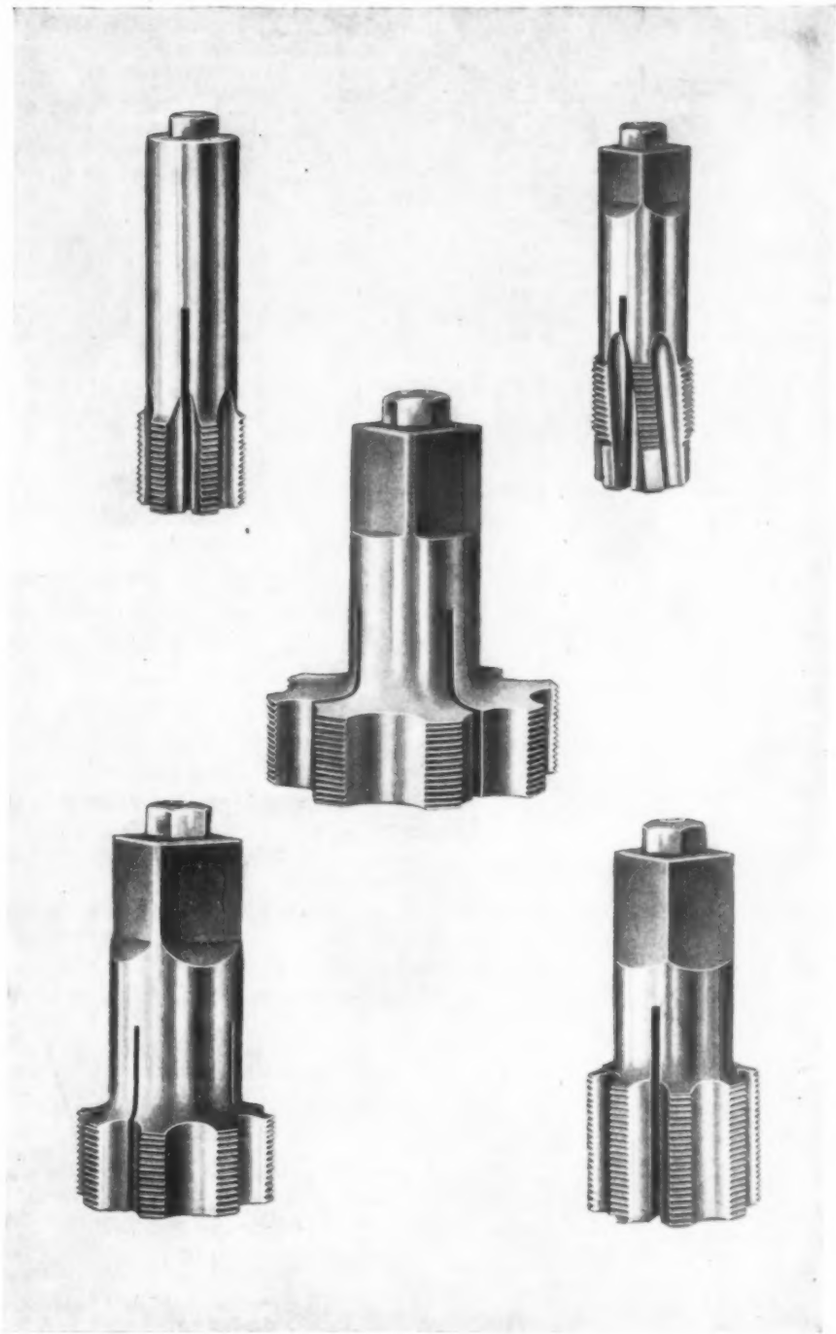
MINNEAPOLIS, Strong-Scott Mfg. Co., 413 Third Street, S.
ATLANTA, Earl F. Scott, M. E., 702 Candler Building.
Licensees for Europe: The Westinghouse Brake Co., Ltd., 32 York Road, King's Cross, London, N.

For the Need of the Hour

TAPS



TAPS

ADJUSTABLE FINISHING TAPS

One of our factories is devoted to handling special screw cutting problems. The men in charge are used to being "up against it." They have gotten many a manufacturer out of his difficulties.

Forty odd years' accumulation of experience helps some. What can we do for you?

Send for the complete catalog of Screw Cutting Tools.

GREENFIELD TAP AND DIE CORPORATION, Greenfield, Mass.

Wells Brothers Company Division. Wiley & Russell Mfg. Co. Division. A. J. Smart Mfg. Co. Division

New York, 28 Warren St. Chicago, 13 So. Clinton St. Philadelphia, 38 North Sixth St. Detroit, 55, 57, 59 Wayne St.

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Service Efficiency Convenience Economy

From Coast to Coast 37 Producing Plants and Distributing Stations provide an unlimited supply of LINDE OXYGEN for users everywhere.

Purity

Linde Oxygen, made by the liquid-air process, is of the highest purity and efficiency.

Exacting users demand Linde Oxygen, knowing they can obtain a uniformly pure gas, from a convenient source of supply, whether their requirements are large or small or vary from day to day.

Service

Linde Oxygen is furnished in steel cylinders containing 100 and 200 cu. ft. respectively.

A large supply of charged cylinders is kept constantly on hand at all Distributing Stations, ready for immediate shipment.

LINDE SERVICE means no investment except for Oxygen actually received—no expensive overhead, or upkeep charges.

Linde Oxygen may be obtained direct from any of our Distributing Stations. Mail or 'phone your order to THE LINDE AIR PRODUCTS CO., at any of the following points:

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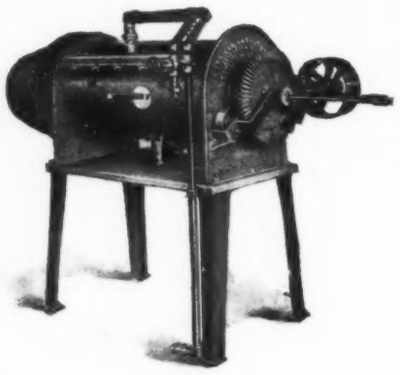
SHIPMENT WILL BE MADE ON DAY ORDER IS RECEIVED

The
Linde Air Products Co.
Forty-Second Street Building, New York

LARGEST PRODUCERS OF OXYGEN IN THE WORLD.

Other Plants and Warehouses are planned for other industrial centers throughout the country and will be established as fast as and wherever the local demand for oxygen warrants.



ANOTHER VICTORY with
American Gas Furnaces

A Pennsylvania concern manufacturing steel washers for rendering automobile tires puncture-proof, became dissatisfied with their hardening process. They used a crude gas furnace, and were thinking of changing to oil for fuel.

A friend told them to come to us. "The American Gas Furnace Co. will save you labor, gas and retorts," is what this man said.

What We Proved

This Company had been hardening 30 lb. of washers an hour. They came to us and we showed them that an "AMERICAN" Gas Furnace would harden 50 lb. in 20 min.—150 lb. an hour! In other words, with our appliance they can do more work in 10 hours than formerly in 24 hours, with LESS GAS and LESS LABOR and BETTER RESULTS.

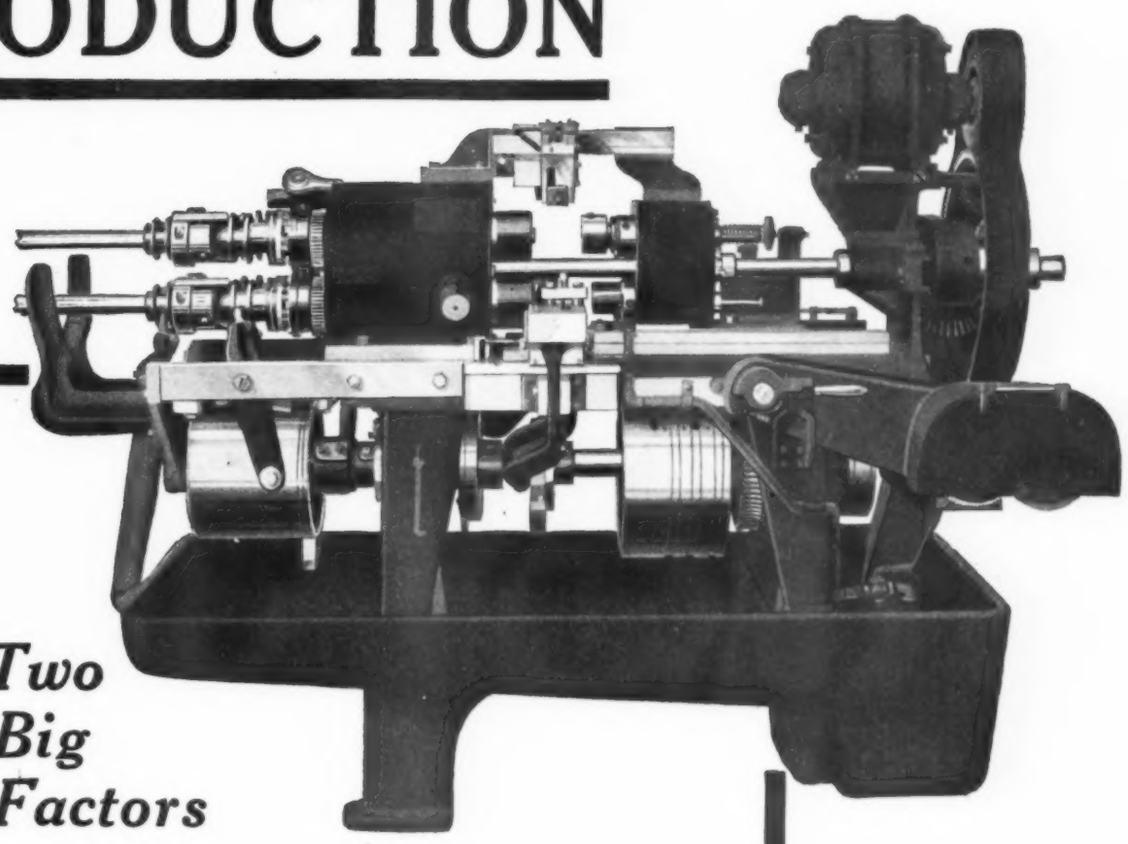
This is a typical victory of AMERICAN Gas Furnaces. The secret is the accurate control of temperature. Write for details—see what we can do for you.

American Gas Furnace Company

Gas Engineers and Manufacturers

24 John Street, New York

PRODUCTION



Two Big Factors

Acme Automatics will turn out screw machine parts complete from bars in the time it takes to make the longest single cut. If your method requires more time, that is time wasted. To reduce the unit of production to less than the time of one cutting operation is impossible.

The number of tools used provide for an unparalleled variation in the classes of work that can be handled on the Acme Automatic. On the simpler work two and three pieces can be made at once—in one operation. Do not forget that this Adaptability is also a factor of production. Capacities up to $2\frac{1}{4}''$ diameter bars.

Acme Automatics will give you that greater 1916 production from your present screw cutting floor space; they will give your present output, from much less space.

Isn't this the kind of equipment you need?

Ask for the Acme Method Book—a complete treatise on Acme Automatics.

NEW YORK
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THE NATIONAL-ACME MANUFACTURING CO.
CLEVELAND

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Conserve Your High Speed Steel

By using Armstrong Tool Holders

MADE IN 11 SIZES, Cutters $\frac{3}{16}$ in. to $1\frac{1}{8}$ in. sq.
also made in Right and Left Offset

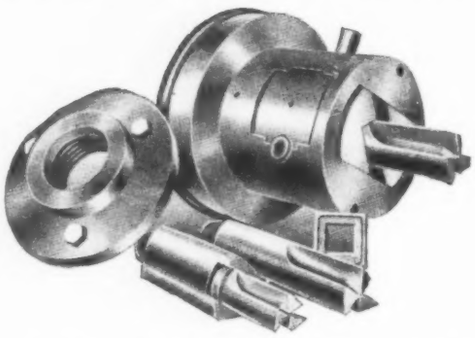
MAKE ONE POUND OF HIGH SPEED TOOL STEEL EQUAL 10 LBS. IN FORGED LATHE TOOLS. SAVE ALL ***FORGING and*** 70% GRINDING.

Our catalog sent for the asking.

ARMSTRONG BROS. TOOL CO.
"The Tool Holder People"
315 N. Francisco Ave., CHICAGO, U. S. A.

ARMSTRONG TOOL HOLDERS WON THE GRAND PRIZE AT THE PANAMA-PACIFIC EXPOSITION

Rectangular Holes?



In advertising "Radbore" Heads for drilling square holes we receive many inquiries as to whether they can drill rectangular holes.

"Radbore" Heads

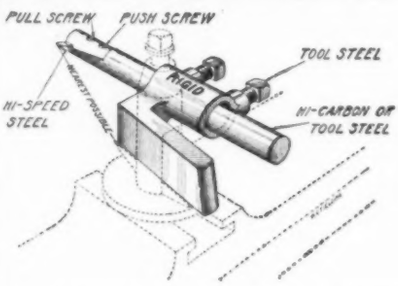
can drill rectangular holes. They drill square holes with sharp corners—with round corners—with flat bottoms.

Radbore Heads are especially suitable for keyway and other half and half work.

If you are in doubt, send a sample of your work to us. We will submit a time estimate. This is a new method and you may be assured of figures entirely within a new limit.

Further details in the "Radbore" Catalog.

Radical Boring Head Corp.
90 West St. New York City



THE

RIGID

Tool Post Boring Tool
(1 of 4 types)

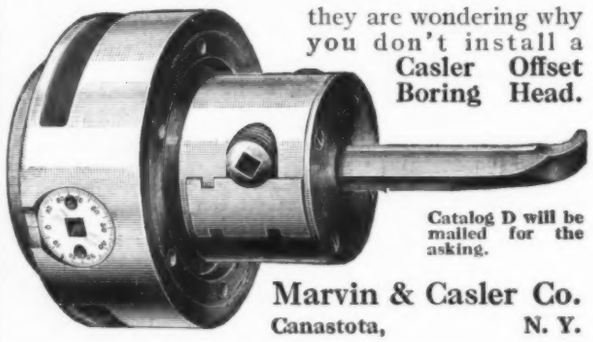
7 Sizes, Bars $\frac{1}{2}$ to $1\frac{1}{4}$".

ANGULAR OPENING between Shank and Barrel brings Cutter "Nearest Possible" to, and directly before Wedge.

Rigid Tool Holder Co., Baltimore, Md.

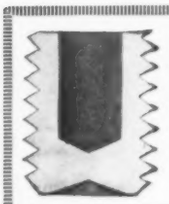
OUT IN THE SHOP

they are wondering why you don't install a **Casler Offset Boring Head.**



Catalog D will be mailed for the asking.

Marvin & Casler Co.
Canastota, N. Y.



Safety
Eagle Set Screws

The only safety set screw which you can buy at a reasonable price. Get illustrated circular and compare our prices.

Progressive Manufacturing Co.
Torrington, Conn.

Expanding Mandrels
Tool Holders—Movable Benches
Power Hack Saws

And all of both superior design and quality.

Western Tool & Mfg. Co., Springfield, Ohio

The Best Dies

bear the name "W L Brubaker & Bros." They are made of the best material and are guaranteed in every particular Try them

Write for Illustrated Catalog.

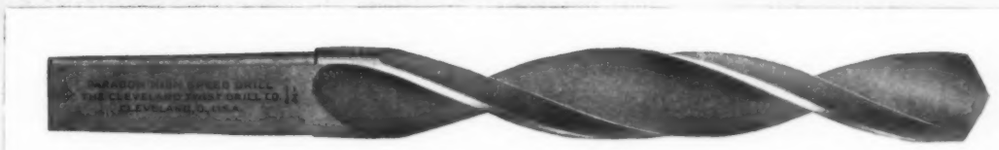
W. L. BRUBAKER & BROS.
New York Millersburg, Pa 50 Church St

DRILLS-CELFOR-REAMERS

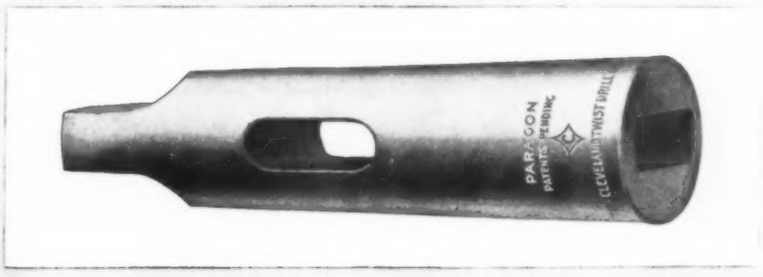
Less power—longer service due to our method of manufacture. We twist the drill from the bar while hot—preserving continuity of fibre and getting better distribution of metal. *Catalog?*

Celfor Tool Co. **Buchanan, Mich.**

"PARAGON" HIGH SPEED DRILLS



INCREASED hole production is assured by the use of "Paragon" High Speed Drills. These drills are hot-forged, without weld or joint, in special dies from the original flat bar. The flutes are scientifically shaped, with straight cutting lips and the maximum chip area.



AS the strain of driving is brought, by our specially designed "Paragon" sockets, to the large end of the shank where it has the greatest cross-sectional area, the "Paragon" Drill has an exceptionally strong and durable drive.

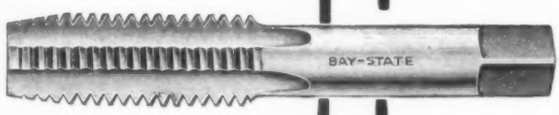
The world's drilling record (57½ inches per minute thru cast iron) is held by a 1¼-inch Paragon Drill

THE CLEVELAND TWIST DRILL CO.

CLEVELAND

CHICAGO: 9 NORTH JEFFERSON STREET NEW YORK: 30 READE STREET

Bay State Taps



Hand Tap

Long Service; Less Breakage

The highest quality of steel, properly tempered and hardened, results in long service taps with a lower percentage of breakage.

Bay State Taps are the result of 15 years' experience in tap-making.

The lead is very uniform and accuracy in each detail of design and manufacture has won an enviable reputation for Bay State Taps.

Each tap is rigidly inspected after each operation. After hardening and finishing, each is tested for strength and freedom from all imperfections. We know BAY STATE TAPS are **right** before we ship them to you.

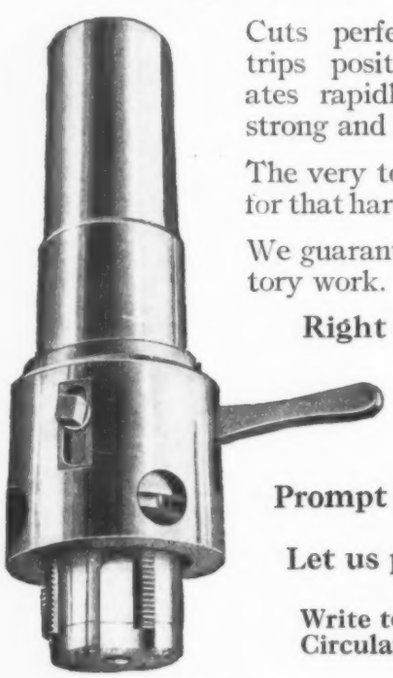
We also manufacture a complete line of Dies and Screw Plates. Our 142-page Catalog gives details of our full line and price lists.

Bay State Tap & Die Co.

Mansfield, Mass., U. S. A.

Representatives for England, Geo. W. Goodchild & Macnab, 56, 58 Eagle St., Southampton Row, London, W. C.

"VICTOR" Collapsing Tap



Cuts perfect threads, trips positively, operates rapidly, is built strong and durable.

The very tool you need for that hard shell work.

We guarantee satisfactory work.

Right Prices.

Prompt Delivery.

Let us prove it.

Write today for Circular No. 10.

Victor Tool Co., Waynesboro, Pa. U. S. A.

It Will Cut to a Shoulder

The quick release of the H & G Automatic Self-Opening Die-Head not only insures the cutting of the thread to a given point every time, but permits cutting right up to a shoulder when required. Other features are described in our booklet. **Write for a copy.**

Eastern Machine Screw Corp.
NEW HAVEN, CONN.

This Mark—A Guarantee On Your Tap Purchases

CARPENTER'S REGISTERED TRADE-MARK **TAPS**

The trade mark stamped on every Carpenter. Looked for by the progressive shop man—the man who wants *results* and *economy*.

C

45 years in the making—45 years getting better—45 years in the lead.

Shall we send our tap Catalog? It's full of interest for the result-wanter.

The J. M. Carpenter Tap and Die Co., Pawtucket, R. I.
Represented in Europe by Alfred Herbert, Ltd.—(Coventry, England) Great Britain; Schuchardt & Schutte—Berlin, Shanghai, Vienna, Stockholm, Tokio, Budapest, Copenhagen, Petrograd. Alfred H. Schutte—Cologne, Brussels, Liege, Paris, Milan, Bilbao, Barcelona.

BESLY FORGED NUT TAPS

Patented.

The Shank Size, Unannealed Blank.

The Forging.

The Finished Tap.

WHY THEY ARE BETTER

Made by an entirely new patented process used exclusively at our Besly Works, Beloit, Wisconsin.

Made from UNANNEALED Tap Steel, so hard and tough that it is necessary to heat the stock in order to cut it off in shears.

Flutes are FORGED, not milled. Forging REFINES, COMPACTS and IMPROVES the steel.

Shanks are the original unannealed bar, specially rolled and planished for accuracy. Therefore, shanks are hard and strong, not softened and weakened by annealing like old style taps.

Threads are MILLED with RELIEF, not chased or cut with dies.

It takes a specially designed semi-automatic thread milling machine thirty minutes to thread one Helmet Temper Tapper Tap. That's expensive but it helps make the most ACCURATE, FREE CUTTING and DURABLE Tap on the market.

A trial will convince you. Send us your orders. Our price is right.

Charles H. Besly & Company, 120 A North Clinton Street, Chicago, U. S. A.

Toolmakers to His Majesty—The American Nut Manufacturer.

Well, What Of It?

What if the tap **does** break and stick in the work. You can get it out in a jiffy and without injuring the thread by using

The Walton Tap Extractor

Look at the picture at the left and see how this handy device works. The crucible steel fingers go down into the flutes, and the rest is easy. Just apply a wrench to the squared outer end and back the tap out. Can you imagine anything more simple?

Think of the money saved—the castings saved from the scrap heap—by applying the **"Walton."** Reasonable in price. Sent on 60 days' free trial.

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The Walton Co.
Hartford, Conn.

B-C Milling Cutters

Pick out the hardest milling job in your shop. and let us supply a cutter for it.

B-C MILLING CUTTERS

can prove their ability to give entire satisfaction on any job, and there is no better place to start than on the hardest.

Make your next order a B-C order.

BARBER-COLMAN COMPANY

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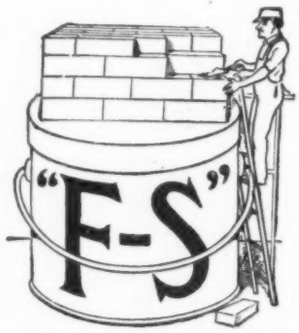

Build on "F-S" Products for substantial results.

Would you like to improve the quality and durability of your machinery finishes? For half-a-century we have made a special study of Priming and Finishing Paints, Enamels and Fillers to suit individual needs. Let us send you free samples.

FELTON, SIBLEY & CO., Inc.

Manufacturers of Colors, Paints, Varnishes, since 1863

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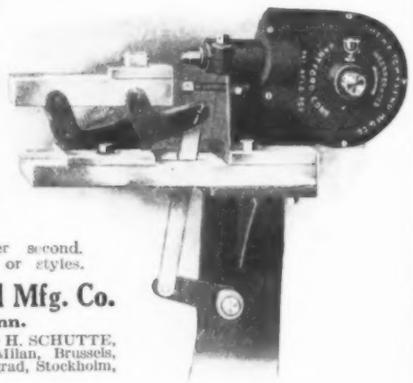
116

Horizontal Multi-Blow Riveting



This machine is a wonderfully fast, convenient riveter for long or bulky work. Strikes 80 to 1000 blows per second. Circular? Other types or styles.

H. P. Townsend Mfg. Co.

Hartford, Conn.

Foreign Agents—ALFRED H. SCHUTTE, Cologne, Berlin, Paris, Milan, Brussels, Liege, Barcelona, Petrograd, Stockholm, Ernst Krause, Vienna.

One Boy or Girl

and one of our **Elastic Rotary Blow Riveting Machines** will do the work of four or five hand riveters, doing it much better—forming every head perfectly.

Makes any shape head required, round, oval, flat, even rectangular.

Send us information about your riveting, and let us recommend a machine which will reduce your costs.

Catalogue 14?

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formerly John Adt & Son

Established 1866 **New Haven, Conn.**

Also makers of Automatic Wire Straighteners and Cutters, etc.

14,000 Rivets Headed for $1.00

on a

GRANT NOISELESS RIVETING MACHINE

A boy or girl at $1.00 per day can head 14,000 rivets on bicycle mud guard braces in ten hours. Rivet heads formed by this machine have a highly polished finish. The machine is absolutely **noiseless** in operation. Breakage of castings or marring of surface articles being riveted, entirely eliminated. We can furnish machines for belt or motor drive for rivets up to ⅜" in diameter.

Send us samples to be riveted and returned to you. Catalog 21.

The Grant Mfg. & Machine Co.

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TURN ON THE AIR!

That's all you have to do, if your Compressor is a SULLIVAN. Sullivan Compressors give air when you want it, at full pressure, for your tools. **Booklet 115-0.**

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Broaching presses, Benders, Pumps, Accumulators, Die presses, Punches, Shears, Shaft straighteners, Bolt forcers, Hydraulic fittings, e c. Write for catalogs. **We build to order to meet special requirements.**

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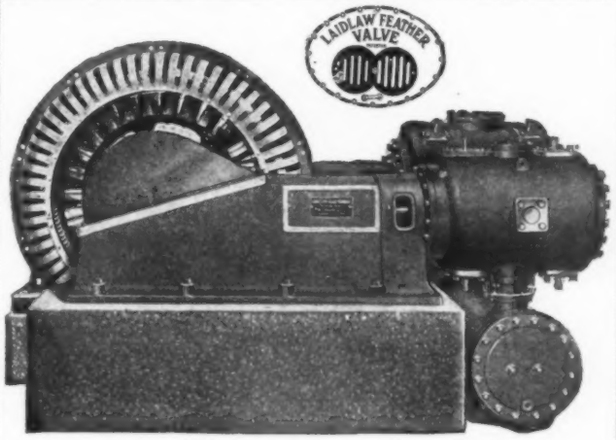

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Feather Valve
COMPRESSORS

include features which greatly increase the return heretofore possible for money invested. These machines have established notable records for low operating costs. Described in detail in Bulletin L-530-11.

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International Steam Pump Co.
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Simplate Disc Valves
are used in
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Send for Bulletin 213 giving full details.

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When You Want To Clean Castings

clean—want to do it quickly and easily, and at the lowest possible cost, the PAXSON-WARREN SAND BLAST MACHINE is the thing to use.
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SAND-BLAST MFG. CO. INC
MACHINES—ALL TYPES
INSTALLATIONS DESIGNED
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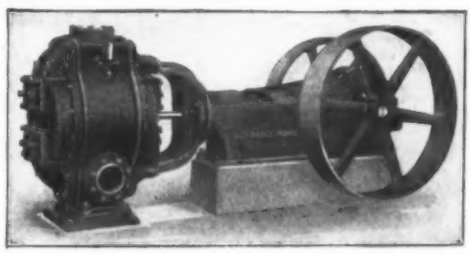

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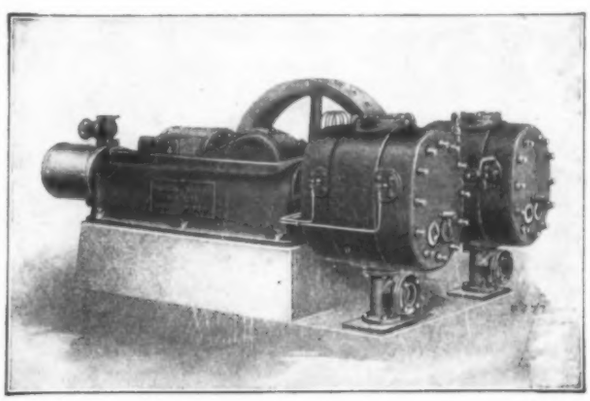
Class "FR"—Piston Valve, Steam Engine Driven.
Class "ER"—Belt, Gear or Short-Belt Motor Driven.

A high vacuum at low cost!

A line of straight-line and duplex vacuum pumps that set a new standard in vacuum service. They are of the wholly-enclosed type insuring cleanliness as well as excluding dust and grit from the reciprocating parts. Automatic Splash Lubrication is a great improvement over oil-cup oiling both from the point of economy of lubricant and in the proper lubrication of the machine.

The floor space required is much less than that of other types. While exceptionally compact and self-contained these machines are thoroughly accessible even while in operation.

Ask for the full description of these machines—mention Forms 733 and 749.



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Type "X" Steam Driven
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INGERSOLL-RAND CO.
New York **Offices the World Over** **London**

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Get Crane Cat. No. 25.

Electric and Air Hoists

TRAVELING CRANES

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For Lifting and Conveying

SAVE TIME—LABOR—MONEY

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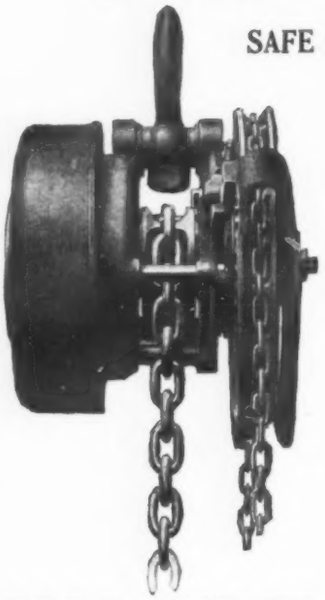
FORD TRIBLOC CHAIN HOIST

SAFE IN EVERY DETAIL



The Patented Loop Hand-Chain Guide protects the working parts and means safety. Planetary gearing means high efficiency. Steel parts mean long service. It has a 3½ to 1 factor of safety in its weakest part, and eighty per cent of the power applied to the hand chain is effective.

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140 Oxford Street, Philadelphia, Pa.

Strength and Simplicity

Are Combined in the Gears of the

Peerless Hoist

No cast teeth—They are all accurately cut from solid steel, and have bronze bushings. The central pinion is heat treated, to prevent wear, and has never been known to break.

All parts are made standard and are easily replaced when worn.

Ask your dealer to send you a Peerless of any capacity.

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Chain or Sprockets

Any Size
Excellent Quality
Prompt Delivery

If you need motor truck chains in a hurry let us supply you. Or any other kind of chain for any sort of drive. A complete list of Sprockets, too. Illustrated catalog No. 18 on request.

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ELEVATING, CONVEYING AND POWER TRANSMITTING MACHINERY

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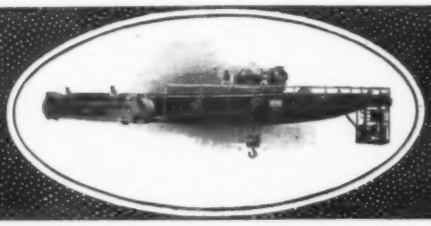

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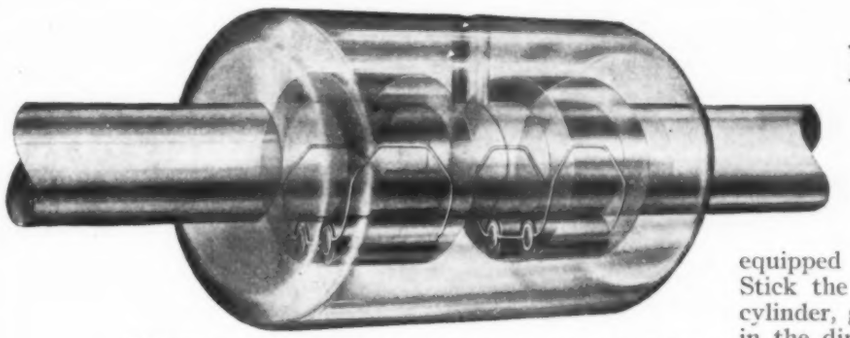
Predominating standards for over a quarter of a century



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Nothing Could Be Simpler

than a metal cylinder containing two eccentric chambers, each of which is equipped with a pair of steel rollers. Stick the shaft in at each end of the cylinder, give the cylinder a slight turn in the direction of the load, and there you are.

Bull Dog Shaft Coupling

is precisely as described above. It automatically locks itself and stays locked, banishing forever all the coupling troubles which have annoyed you in the past.

There is not a screw, nut or keyway about it—it is just as smooth as the shaft and never can harm any of your workmen, even if they lean right up against it when it is spinning at top speed.

You owe it to yourself to learn all about this money-saver. Better order a few for a real working test in your own plant. If none of the dealers listed below can supply you, order direct from us.

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72-24

2½ Million Bought

The mechanical advantages of AMERICAN Steel-Split PULLEYS and the pulley service that they make possible, have caused pulley users to buy over 2½ million. More AMERICAN Pulleys are bought than of any other one make.

Just consider for a minute the confidence that this reflects. Estimate the number of pulleys in your plant that might be steel split, and then you'll get the significance of this tremendous output.

Easy application, light weight, minimum air fanning, unusual strength, double belt service—these are some of their characteristics.

Fifty thousand pulleys stocked for immediate delivery at New York, Boston, Chicago, Seattle, and at the factory, besides thousands of others in the stores of over 200 dealers. Sizes 3″ to 120″.

Full information, catalogs and prices will be sent promptly on request.

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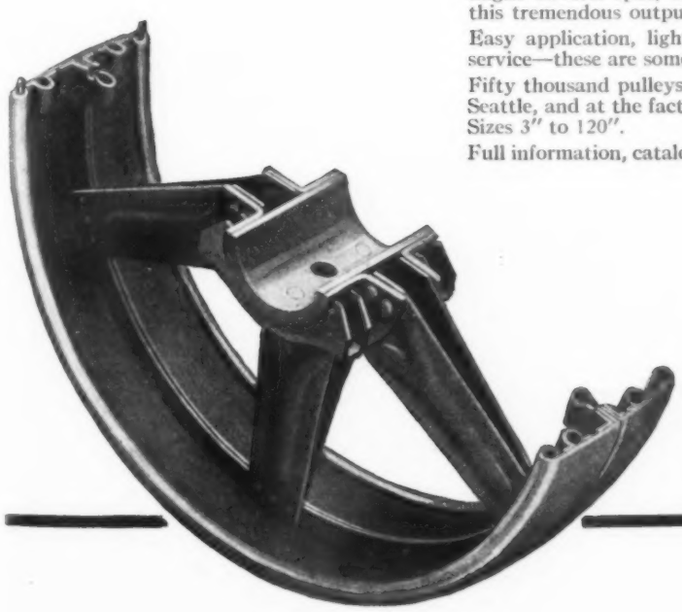

American Pulley Company
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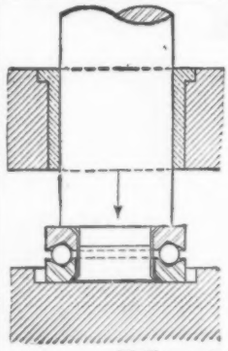
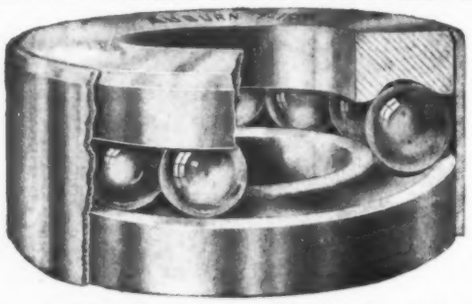
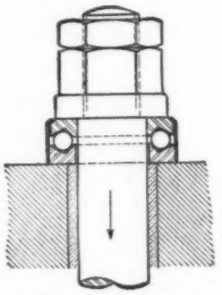
AMERICAN
STEEL SPLIT PULLEY



THE ANSWER TO THRUST DIFFICULTIES LIKE THESE





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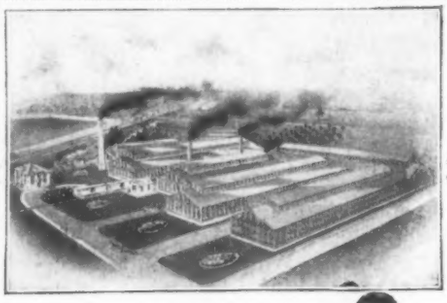

Where 12,000,000 Steel Balls Are Made Daily

In this plant we make over 12,000,000 steel balls per day—and each one is *precise* in its sphericity—accurate to a degree which we believe is not approached by any other steel balls made either in America or in Europe.

HOOVER Steel Balls

possess uniform hardness from core to surface—with a crushing strength of over 100,000 lbs. per ball and astounding durability. Each one must pass our triple inspection. Only the finest forged-steel, scientifically heat-treated, is used in Hoover Steel Balls.

Write for latest catalog No. 2 and prices.

Hoover Steel Ball Company
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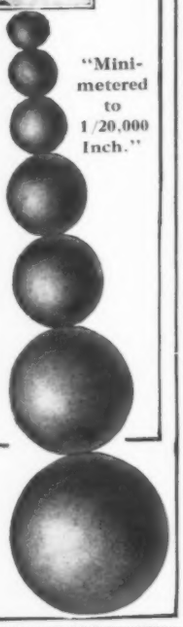

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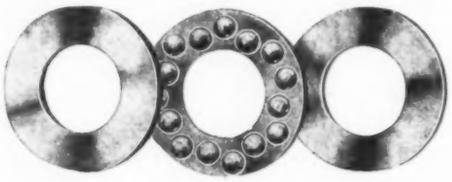

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You won't have to go very far to get proof that Anti-Friction Bearings possess many advantages over the ordinary plain bearing.

There are thousands of machines in use in most every line of manufacture where Anti-Friction Bearings are proving their worth.

Once adapted, always used.

We will gladly furnish you information.

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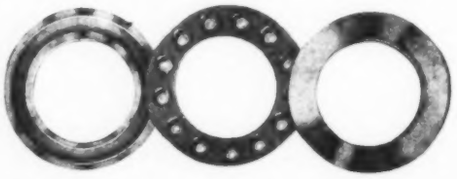

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BALL
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THE NORMA COMPANY
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1790 BROADWAY
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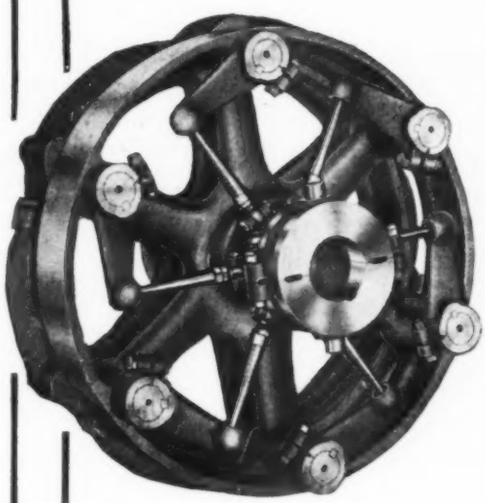
Buy a Caldwell Friction Clutch

Send for Catalogue A1

Applied to Iron and Wood Pulleys, Gears and Sprocket Wheels, Gas Engines

W. E. Caldwell Co. (Inc.,) Louisville, Ky., U.S.A.

The LOMBARD Clutch Is Thrown into Action with the Least Possible Exertion



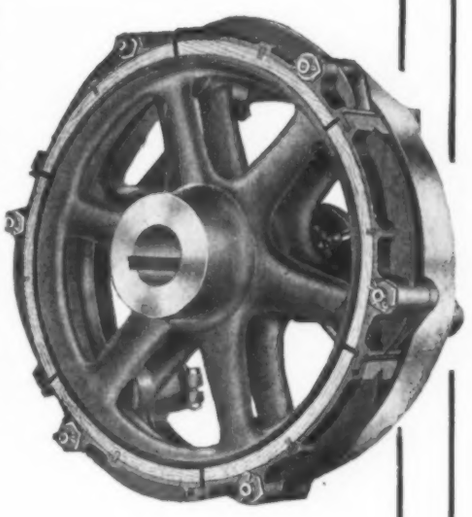
This new idea in Friction Clutches is of the **External Rim Friction Type.**

There is a **complete circle of external friction surface**—wood to iron.

When the **Lombard** is thrown into action—and this is done with the least possible exertion—the clutch grips with a tremendous holding power.

Lombard Clutches are simple, durable and free from springs. They are self-centering and it is only a matter of a few minutes to remove the shoes for a renewal of the woods.

Lombard Clutches are made in a great variety of sizes from 8″ up to 46″. Larger sizes made up special. Sizes from 16″ up furnished split, if desired.



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ROCKWOOD
Paper Frictions

High Speed, Quick Starts and Sudden Stops

These are essential in many forms of machinery. Friction Transmission displacing toothed gears under conditions, cuts out the noise—gives higher efficiency and avoids liability of breakage from sudden shocks.
Rockwood Paper Frictions are the acknowledged standard. Made to fit your specifications.

Our booklet, "Friction Transmission," gives data and formulæ invaluable to the designer. *Sent free on request* to those who state occupation and firm connected with.

The Rockwood Manufacturing Co.,
1910 English Avenue, Indianapolis, Ind., U. S. A.

Investigate!

Here's a coupling that will take care of all misalignment troubles. The

CLARK FLEXIBLE COUPLING

is simple, strong and reasonable in price.

Write for details and price list.

Clark Flexible Coupling Co., Inc.
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A Safe, Strong Clutch

The **Edgemont Friction Clutch** was built especially as an absolutely safe, powerful appliance. It is of metal on metal expansion friction design. Standard diameters.

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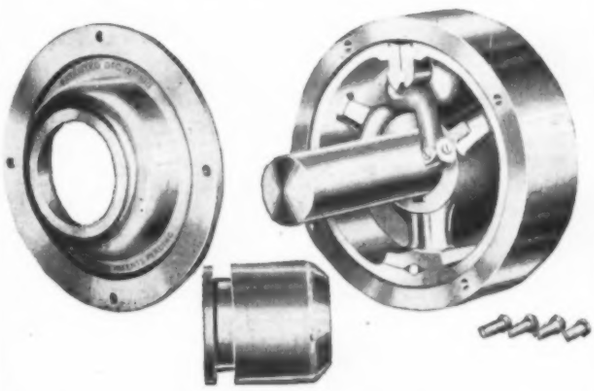
The Edgemont Machine Co., Champie & National Ave., Dayton, Ohio

Dust, Oil and Grit Proof



The Cleveland Clutch

Every feature is designed to eliminate all trouble for you—it's self-oiling and easily adjusted. Adapted to all purposes.

Occupies the least space per H. P. and is built in sizes up to 275 H. P.

All details in the latest catalog.

Write now.

The Reliance Gauge Column Co.
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$22.00

A Light Clark Three-Wheel Transfer Truck

One of the famous "Clark Line."

Price is so low that several of these may be purchased and prevent delays occurring from waiting around for a truck to come up.

Has 1½" raise.

Write for Descriptive Bulletin L-31. For loads up to 2,200 lb. we have another model at $45.00.

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You Need This Book; Send for It—

It's free for the asking. The tables are valuable, the belting information of practical every day use. A handy book for every belt user.

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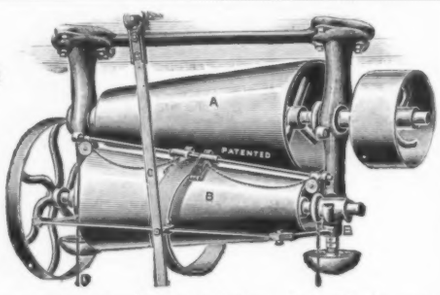
The Graton & Knight Mfg. Co.
Bloomingdale, Worcester, Mass., U. S. A.

Evans Variable Speed Counter Shaft



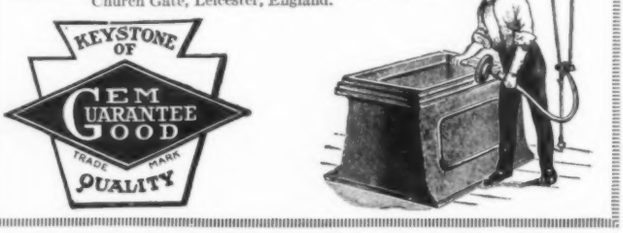
For transmitting different speeds to your machinery, from 1 to 6, there's nothing so easy and so simple as this device. Just pull the cord and the speed is changed to that desired while the machine is running. You can stop and start again at any speed. It is noiseless, powerful and positive in action. Made for floor or hanging use. *Write for Catalog* 25.

Evans Friction Cone Co., Newton Centre, Mass.
A. Warden & Co., 48 Shepherdess Walk, City Road, London, E. C., England.

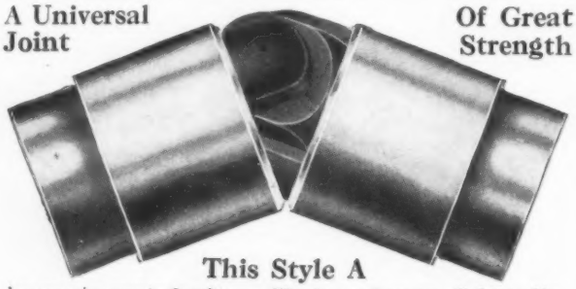
GUN METAL SEGMENTS

In the Gem Flexible Shaft transmit maximum amount of power in the longest length sections.
Forget about the wire-cored shafts when you think of the "Gem."
Write for Catalog and read further details.

Gem Manufacturing Co.
3257 Spruce St. Pittsburgh, Pa., U. S. A.
English Agents—A. A. Jones, Pollard & Shipment Co., Ltd. Church Gate, Leicester, England.



A Universal Joint Of Great Strength



This Style A

has superior wearing qualities. Wearing surfaces are all thoroughly case hardened a feature which means long life. No sharp corners or edges. Sizes ½' to 2½". **Write today for Illustrated Circular.**

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Get the "Jackson Book"

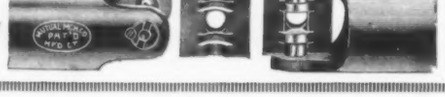
Imitations of Jackson Belt Lacing Machines are confusing, especially if you don't know where the difference is. The "Jackson Book" tells all about Jackson Belt Lacing Machines. Get a copy and you can't go wrong when you purchase.

Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.

The Forks Do Not Spread on These Universal Joints

The center block has recesses into which the headed projections on the forks fit, preventing their spreading. Our joints are made from the finest materials and are self lubricating.
Price list and catalog on request.

The Mutual Machine Company
29 Wells Street, Hartford, Conn.



Save Time in Buffing
and burnishing small metal parts by placing them in the

ABBOTT
Burnishing Machine
and turning on the power. One unskilled man can do the work of many experienced burnishers.
Catalog No. 8 tells all. Write.

Abbott Ball Co.
P. O. Box 1233, Hartford, Conn.

Arguto NON-METALLIC **Oilless Bearings**

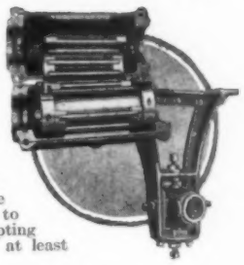
for loose pulleys, friction clutches, high speed machinery. Eliminates lubrication—runs from 8 to 15 years without oiling.

ARGUTO OILLESS BEARING CO.
147 Berkley Street Philadelphia

A Trouble-Proof Joint
That's the kind you get if you insist upon
DART UNIONS
They're the kind that *stay* perfectly *tight* under all service conditions. Bronze to bronze seats can't corrode. That's why. Send for *free* sample, literature and price list No. 20.

E. M. Dart M'f'g Co., Providence, R. I.
The Fairbanks Co., Sales Agents.—Canadian Factory, Dart Union Co., Ltd., Toronto.
Ask your dealer for prices.

They Fit Any Standard Hanger



Suppose you were to leave your plant some night—and returning next morning, were shown that friction load on your line shafts had been *permanently reduced* from 25 to 50 per cent, lubrication 50 per cent, and wear to an almost negligible quantity. Then—

Suppose the whole change had been made *over night*, without disturbing a single hanger, shaft, pulley or belt! Wouldn't you feel that the man who had brought this big saving to your organization, *without* interrupting operation, had deserved a raise—or at least commendation?

There are hundreds of plants where just this has happened. "Sells" Roller Bearings—"Old Reliable Sells"—have been installed in just this way—easily, quickly, permanently, because they fit all standard hangers, and because they are *all split*, like any babbitt or ring-oiling bearing.

I will be glad to tell you more of this "over night" service, if you will write me.

John D. Sells
Manager.

ROYERSFORD FOUNDRY & MACHINE CO.
50 North 5th Street, Philadelphia

Babbitted Ring Oil Bearings — Shaft Hangers, Collars and Couplings—Punches and Dies—Punching and Shearing Machines—Sensitive Drill Presses—Drill Presses—Foot Presses—Grinding and Polishing Machines—Tumbling Barrels—"Rollerine"—the ball and roller bearing lubricant.

"SELLS" Roller Bearings

Franklin Die-Cast Parts

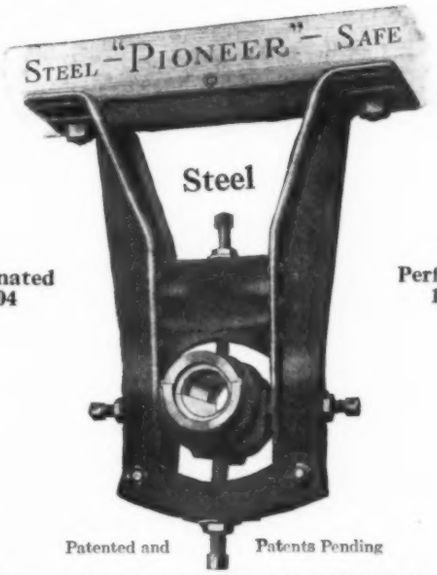
Franklin Dies are capable of producing from one hundred to two thousand parts per day, according to size, shape and number of parts cast at a time. The same output by the usual machine methods would be impossible except with large floor space and expensive machine equipment.

This feature is of special advantage in the manufacture of new inventions or the meeting of rapidly increasing demands.

Write for Booklet "H," which tells what Franklin experience means to the user of die-castings.

FRANKLIN MANUFACTURING COMPANY
400 South Geddes Street, Syracuse, N. Y.

NIGHT AND DAY



Originated 1904 **Perfected 1914**

Patented and Patents Pending

AND NEW ADDITIONS

That's the record of our factory, so as to keep pace with our sales of the 1914 design "Pioneer" SAFETY STEEL Shaft Hangers.

Standard Pressed Steel Co.
Philadelphia, U. S. A.

You can't hurt a duck's feelings with water any more than you can injure Schieren's Duxbak Waterproof Leather Belting by placing it where moisture attacks it continuously.

You will never know what the use of Duxbak can do for you until you try one belt on a particularly hard drive.

Come on—try just one even if it's the smallest you use—

We secured the Gold Medal of Honor at the San Francisco Exposition—this is another time we've won.

Chas. A. Schieren Company — Established 1868

DUXBAK BELTING
TRADE MARK
Reg. U. S. Pat. Off.

Tanners
Belt Manufacturers

69 Ferry St., New York

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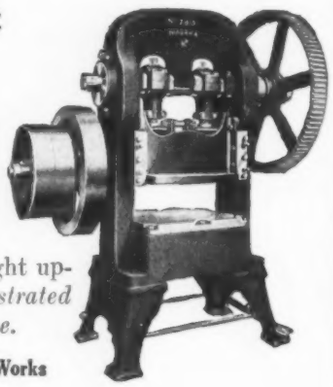
For Low Cost Press Work



this No. 79 B Niagara Double Crank Press is invaluable. It's a heavy, strong, powerful machine that secures large output at low cost. Geared, straight uprights. *Send for illustrated Catalog showing full line.*

Niagara Machine and Tool Works
Buffalo, N. Y., U. S. A.

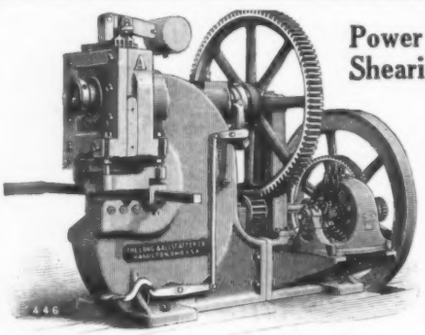
Waltham Sub-Presses and Dies

Save time by using Waltham Sub Presses on all sorts of intricate pieces. One blow will finish a piece, absolutely accurate.

No danger of dies getting out of line. Saves time in changing from one die to another.

Get all the details.

Waltham Machine Works
High St., Waltham, Mass.



Power Punching and Shearing Machinery

of all kinds and Sizes

Belt, Steam or Electrically Driven.

For Light or Heavy Work.

Designed and manufactured by

(Heavy Bar-Iron Shear, Electrically Driven)

The Long & Allstatter Co.
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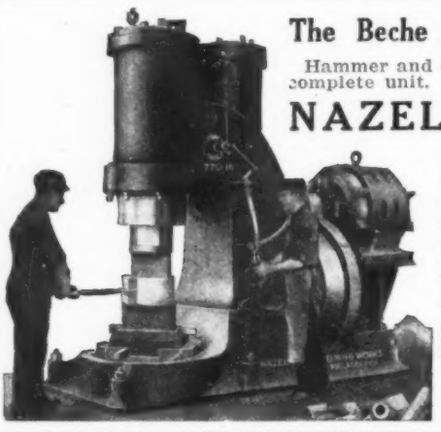
The Beche Air Hammer

Hammer and compressor one complete unit.



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More economical than steam, more powerful than springs, more efficient than either.

Built in 6 sizes, Belt or Motor.

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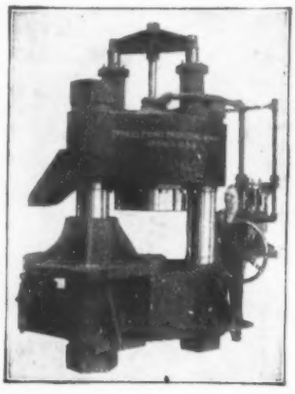

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Anyone Can Engrave with This Engraving Machine of Ours

It doesn't take an expert to operate it, so you not only save the cost of a high priced man, but the ordinary workman can turn out work better than the most skillful hand engraver in a fraction of the time the hand workman would take. It is for engraving name and direction plates and similar work.

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There is nothing to offset the saving when you invest in an Atlas Press. You get two presses for the cost of one when you install Atlas Presses. **Write for the Atlas Bulletins.**

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COVINGTON MACHINE COMPANY
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Little Giant Power Hammer

with or without individual motor drive.

400 R.P.M.

Machine-gun rapidity and precision.

Sold on 30 days' trial by your jobber, or

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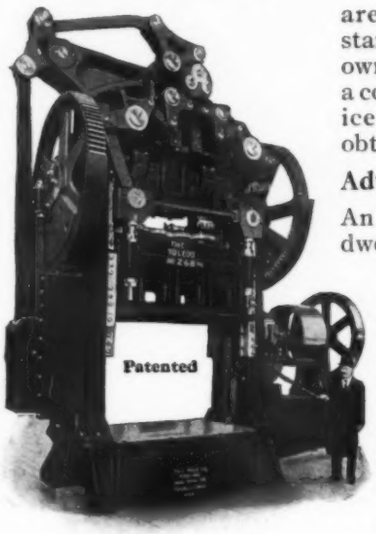
HUNDREDS OF SIZES AND STYLES

FOR CUTTING, FORMING, PUNCHING, DRAWING AND EMBOSSING BAR AND SHEET METALS, PAPER, LEATHER ETC

FERRACUTE MACHINE CO., BRIDGETON, N. JERSEY, U.S.A.

"Toledo" TOGGLE Drawing Presses



are creating a standard of their own and rendering a conspicuous service never before obtained.

Advantages:

An absolute rest of dwell through more than 90° of the travel of the plunger.

Elimination of wasters.

Perfect timing and consequent silent running and safety to operator.

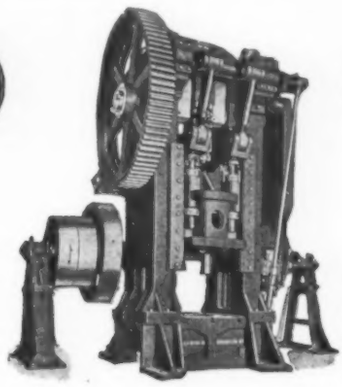
Massive construction which minimizes maintenance cost.

60 sizes, single and double crank—weighing from 6550 to 400,000 lbs.

For work varying from the smallest and simplest to the most difficult special forms and shapes.

The Toledo Machine & Tool Co.
Toledo, Ohio

BLISS BLISS



The Uniform Pressure Makes Every Shell a Good Shell

The action of the Bliss patent toggle motion facilitates the work and requires less power. Blank holding pressure is taken by the frame, relieving bearings.

Bliss Toggle Drawing Presses

The blank holder starts on its upward movement nearly simultaneously with the punch, giving operator ample time for removal of drawn piece. Bliss Toggle Drawing Presses are built in many sizes and cover every requirement. Let us send you descriptive matter covering your exact requirements. **Write today.**

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Latest Improved Design insuring rapid and satisfactory production

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Pack More Metal into the Parts—Swage Them

THE swaging process is to hammer, squeeze and knead metal into any shape. That toughens it. The Dayton strikes from 2,000 to 6000 blows a minute.

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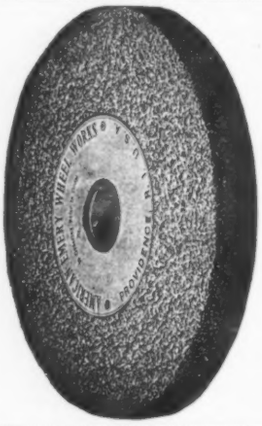
Coventry Swaging Co., Ltd., White Friars Lane, Coventry. Agents for Great Britain: Fenwick Freres & Co., 8 Rue de Rocroy, Paris, France. Agents for France, Italy, Belgium, Spain, Portugal and Switzerland.



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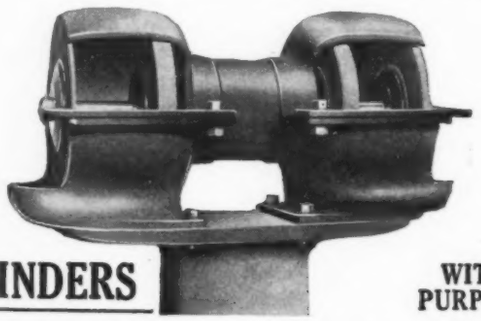
GRINDING WHEELS
Made of either
Corundum, Carbolite or Emery
VITRIFIED
SILICATE
ELASTIC
Processes, in every size and shape, for all grinding operations

CATALOG

American Emery Wheel Works
Providence, R. I., U. S. A.



GRINDERS WITH A PURPOSE

Here is a grinder designed especially for use in pattern shops. **Write for particulars.**

FORBES & MYERS, 170 Union St., Worcester, Mass.

$60 GRINDER

BUILT BY
THE BLAKE & JOHNSON CO.
WATERBURY, CONN.

$50
Net, f. o. b. La Salle

Not Much Money
But it buys the best Micrometer Grinder you ever saw—or anybody ever saw—for that sum. Can make immediate delivery.

May We Send Folder?

La Salle Machine and Tool Co.
La Salle, Ill. U. S. A.

This cut shows the No. 170 Universal Grinder

The No. 164 Wells Grinder For $90.00

By manufacturing in larger quantities than usual, we are able to give you the only low-priced cutter and reamer grinder having **a swivel table with vertical adjustment** for using cup-wheels as easily as any other form. We've a new Catalog No. 10, that tells of this low-priced, accurate, high quality Wells. Write for it.

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GREENFIELD, MASS. U. S. A.

Pay When You Are Satisfied

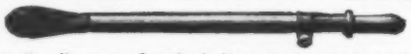
Not until Vitrified Grinding Wheels show an improvement in the quality of your work are you expected to pay for the wheels in use.

All you are required to do is to order the proper grade of Vitrified Grinding Wheels for your work. The wheels will do the rest.

Write for free trial data now.

The Vitrified Wheel Co.
Westfield, Mass.

The Diamo-Carbo Dresser



Dresses all ordinary grades of grinding wheels—used for 10 years by large shops **Write for bulletin and trial offer.**

DESMOND-STEPHAN MFG. CO. Urbana, O.
Manufacturers of Diamo-Carbo, Sherman and Huntington Emery Wheel Dressers

Sterling Grinding Wheels

Place Your Grinding Department on a Paying Basis. They insure Maximum Output. :: :: ::

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LONG LIFE — EFFICIENT SERVICE
FOUND IN
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GRINDING AND POLISHING MACHINERY
DIAMOND MACHINE CO. Catalog X yours for the asking PROVIDENCE, R.I.

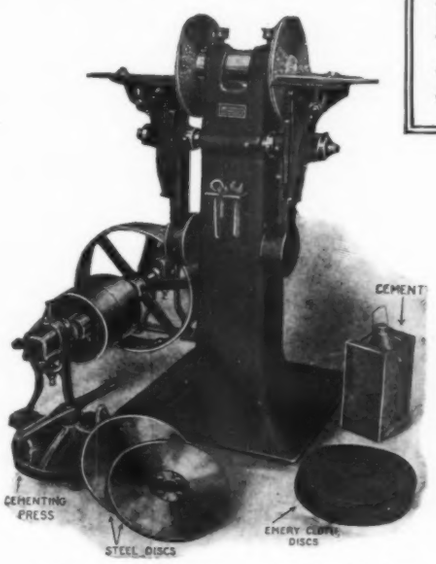
TRUE GRINDING WHEELS WITH DIAMOND TRUES

They quickly make perfect grinding surfaces—always ready to use. **Write for further information and prices.**

ARTHUR A. CRAFTS, 125 Summer St., Boston, Mass.

They Work for You Night and Day

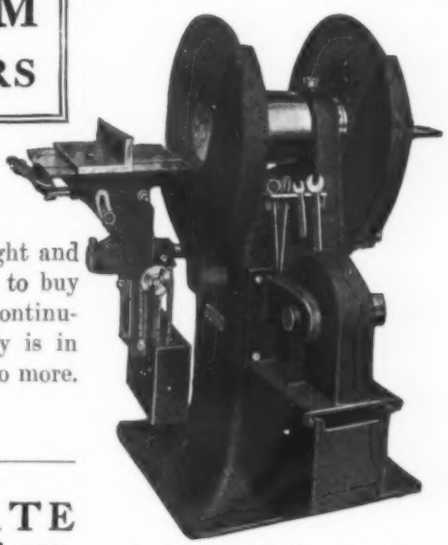
ROWBOTTOM DISC GRINDERS



The Rowbottom 12" Ball Bearing Disc Grinder

Are built for a "three shift" day. If you don't want grinders to work night and day isn't it good business to buy the kind built to stand continuous service? This quality is in Rowbottoms and it costs no more.

INVESTIGATE
Write for Bulletin "E" now.



Rowbottom 26" Ball Bearing Disc Grinder with Exhauster.

The Rowbottom Machine Company

Builders of Cam Milling Machines, Disc and Surface Grinders, Punch Presses and Special Machinery.

Waterbury, Conn., U. S. A. **Factory, Waterville, Conn., U. S. A.**

The *Greenfield*

A universal grinder with a complete set of fixtures for handling all kinds of tool sharpening, cylindrical, internal and surface grinding. **Sturdy, dependable, accurate, rapid. Catalog No. 5 on request.**

Greenfield Machine Company
Greenfield, Mass., U. S. A.

Bryant Chucking Grinder Co.

Springfield, Vermont, U. S. A.

Builders *of* One, Two *and* Three Spindle Chucking Grinders

EUROPEAN AGENTS—Germany, Holland, Switzerland, Italy, and Austria-Hungary, M. Koyemann, Charlottenstrasse, 112, Dusseldorf, Germany. Great Britain, James R. Kelly & Co., Ltd., 3 and 5 Bridge End, Leeds Bridge, Leeds, England. France, Belgium and Spain. F. Auberty & Co., 91 Rue de Maubeuge, Paris, France.

Pick the Wheel Best Suited to Your Work

Let us advise you just which Carbondite wheel will give you the most economical results.

We believe Carbondite is the hardest and best abrasive obtainable.

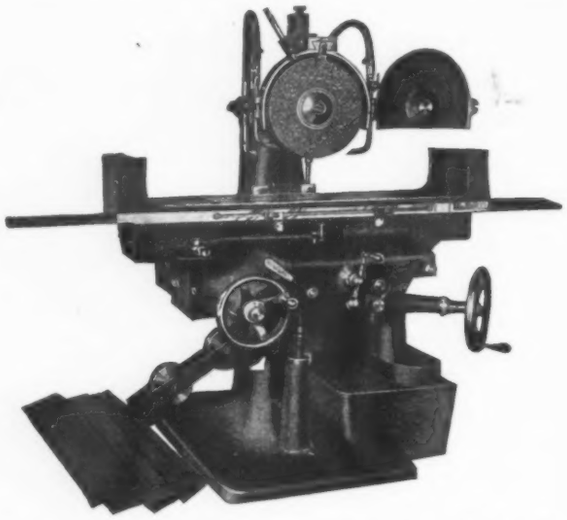
Made in the electric furnace and is exceedingly tough.

Carbondite wheels do not glaze over—they cut free and fast.

Write for latest catalog.

Safety Emery Wheel Co.

Larch Street **Springfield, Ohio**



Don't Spoil Any More Work

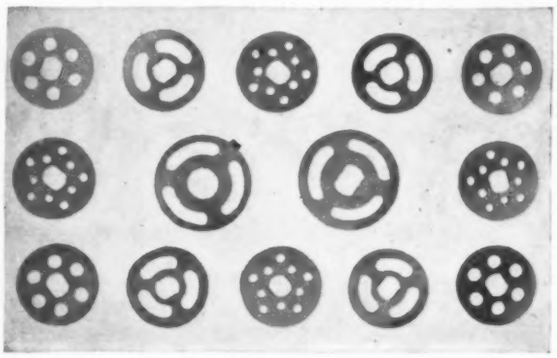
You diemakers and others who know what it is to spoil weeks of work through a few minutes of dry grinding, will appreciate this new No. 3 W. & M. Wet Surface Grinder.

With the Table Water Guards in place, it is a complete wet surface grinder. Remove them and it is ready for all kinds of dry surface grinding.

Capacity is 8″ x 24″ surfaces. Cuts as heavy as .070 of an inch can be taken without overheating the work or wheel.

The details will interest you. Write for Circular.

WILMARTH & MORMAN COMPANY
1187 Monroe Avenue, Grand Rapids, Mich.



300 Ground on Both Sides Every Hour on a BLANCHARD

These food chopper discs, 2¾″ diameter, made of soft steel, are ground on both sides on a **Blanchard High Power Vertical Surface Grinder** at the rate of 300 per hour. Fast work—but typical of the Blanchard.

We'd like to tell you more about Blanchard grinding speed and about Blanchard accuracy, especially as applied to your own work. **Why not send blueprints or samples and get our figures?**

The Blanchard Machine Co.
64 State Street, Cambridge, Mass.

Two Kinds of Work on One Machine — Economy

Blount Combination Grinding, Polishing and Buffing Machines are true economizers in the shop. Only one machine is required for both grinding and polishing; a direct saving of the cost of one machine. Two kinds of work or two men may use the same machine at the same time.

Ask Your Dealer About It

Blount Combination Machines

The machine shown is our No. 5 with Self-Oiling Bearings. This, and the No. 4 Combination Machine are built with a cone pulley on countershaft for speed regulation.

Send for descriptive catalog. We manufacture a full line of Grinding Machines and Speed Lathes.

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Hands Dirty? Try CLEANZUM

Cleanzum is an ideal hand soap that instantly removes grease, dirt, stains, etc., from the hands without cracking or making them rough.

We want a live Selling Agent in every shop. Write for particulars.

White & Bagley Co. Worcester, Mass.

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Manufacturers of Electric Motors, Generators and Transformers.

Office and Works: Ampere, N. J.

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JAPANS FOR CASTINGS

A manufacturer of castings writes of one Japan: "It gives a handsome finish even on rough castings."

Let our experience gathered through fifty-one years of aiding concerns in every industry, help you get the finish your product demands.

Ask for "Finishing Booklet."

MOLLER & SCHUMANN COMPANY
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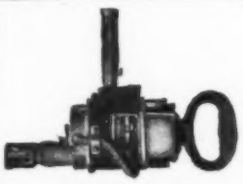

Expensive Equipment Is Not Always Necessary

Take U. S. Electric Tools to the work and save four-fifths of the time usually required on each job. Every kind of portable drill, grinder and buffer ready for prompt delivery. **Write for Catalog.**

The United States Electrical Tool Co., Cincinnati, Ohio

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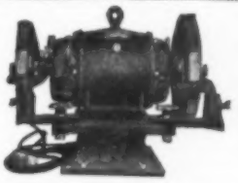


Westinghouse Motors *for* Driving Machine Tools

W WESTINGHOUSE ELECTRIC

of every type and size, in every kind of service, from every commercial electric circuit

Westinghouse Electric & Mfg. Co.
East Pittsburgh, Pa. Sales Offices in 45 American Cities

C & C SHOP MOTORS

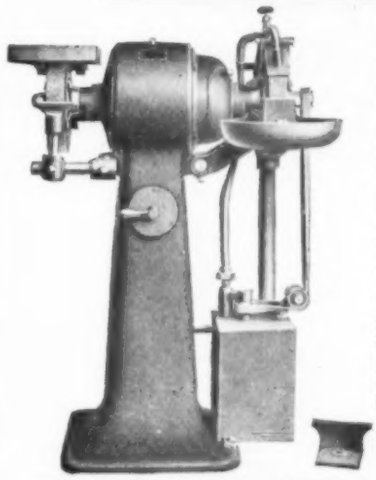
C & C Motors with 5 to 1 speed range by direct field control excel for driving machine tools. They are exceptionally conservatively rated. The motor frame is of ample size to prevent crowding of windings and they have an excess radiating surface throughout all parts of the field windings, armature and commutator that assumes highest overload capacity, cool, sparkless operation and **absolute reliability.**

Built in the open, semi-enclosed and enclosed dust- and water-proof types, in all sizes. Write for our Bulletin Type SL Motor.

RELIABILITY
C&C ELECTRIC & MFG. CO.
GARWOOD, N. J.

130

"WILLEY" TOOLS
Wet and Dry Grinder



The water attachment added to a "Willey" Standard Floor Grinder makes a combined wet and dry grinder suitable for a wide range of work.

The attachment consists of hood, splash bowl for wheel, water reservior and settling chamber; fitted with a centrifugal pump which is bolted to the bottom of the pedestal.

The pump is driven from a pulley on the wheel shaft. The whole attachment can be easily removed when it is necessary to convert the machine into a double dry grinder.

Write for the "Willey" Catalog.

"WILLEY" TOOLS - ALL WAYS CORRECT MECHANICALLY - ELECTRICALLY

James Clark, Jr., Electric Co., Incorporated
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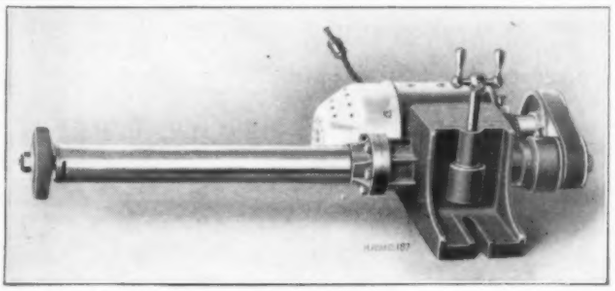
CHICAGO, 202 Machinery Hall. PITTSBURGH, Pa., 1308 First Nat'l Bank Bldg. PHILADELPHIA, 532 Parkway Bldg. Room 400-E, 30 Church Street, NEW YORK, N. Y.



Combination Internal and External Precision Grinder.

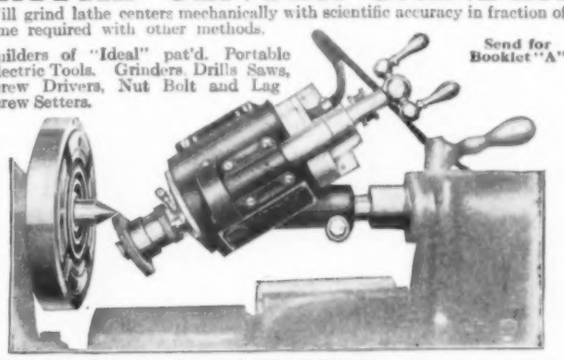
The Hisey-Wolf Machine Co.
Portable Electric Tools. CINCINNATI, O.
New York Office: 50 Church St.

LATHE CENTER GRINDER

Will grind lathe centers mechanically with scientific accuracy in fraction of time required with other methods.

Builders of "Ideal" pat'd. Portable Electric Tools. Grinders, Drills, Saws, Screw Drivers, Nut Bolt and Lag Screw Setters.

Send for Booklet "A"

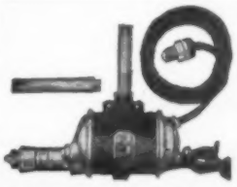


The Neil & Smith Electric Tool Co., Cincinnati, O., U. S. A.

RELIANCE ADJUSTABLE SPEED MOTOR

Runs at any speed over any range up to 1 to 10. No electric controller used. See ad last issue.

Reliance Electric & Engineering Co.
1044 Ivanhoe Road, Cleveland, Ohio



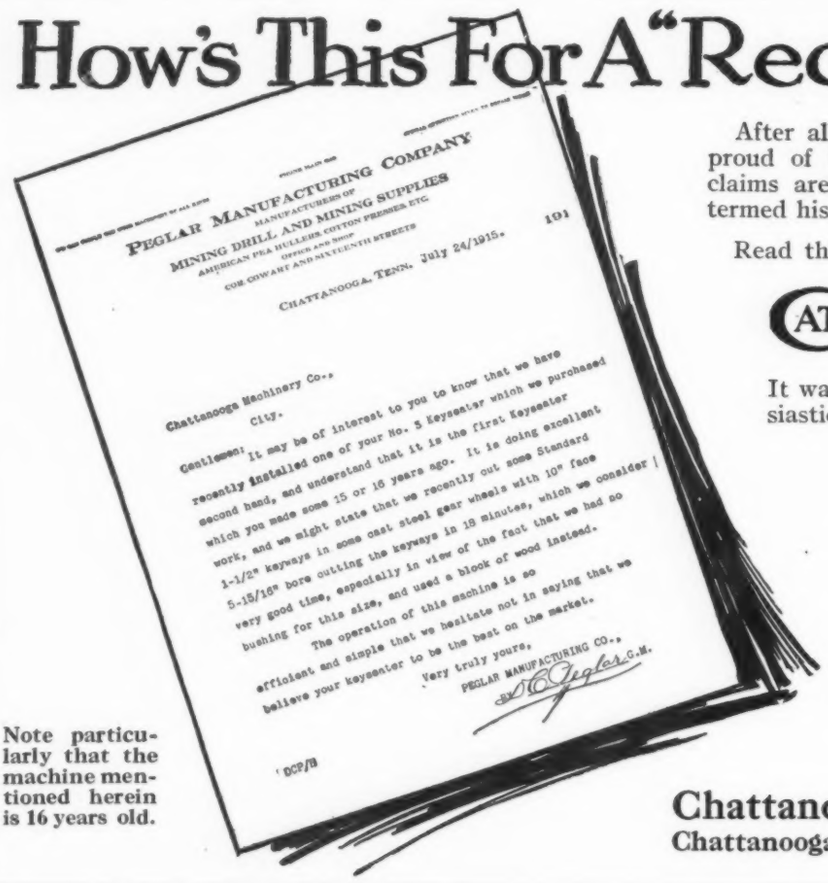
SENT ON TRIAL

We make a complete line of Portable Electric Drills and Grinders for all purposes. Especially built to withstand hard usage. Direct and Alternating Current.

Hand or breast Drills. 12 sizes. ¼ in. to 2½ in. cap. Larger sizes fitted with screw-feed and have 2 speeds. Catalog?

Cincinnati Electrical Tool Co.
Cincinnati, Ohio
New York Office: 50 Church St.

How's This For A "Recommend"?



PEGLAR MANUFACTURING COMPANY
MANUFACTURERS OF
MINING DRILL AND MINING SUPPLIES
AMERICAN PEA HULLERS COTTON PRESSES ETC.
OFFICE AND SHOP
COR. COWART AND SEVENTH STREETS

CHATTANOOGA, TENN. July 24/1915. 101

Chattanooga Machinery Co.,
City.

Gentlemen: It may be of interest to you to know that we have recently installed one of your No. 5 Keyseater which we purchased second hand, and understand that it is the first Keyseater which you made some 15 or 16 years ago. It is doing excellent work, and we might state that we recently cut some Standard 1-1/2" keyways in some cast steel gear wheels with 10" face 5-15/16" bore cutting the keyways in 18 minutes, which we consider very good time, especially in view of the fact that we had no bushing for this size, and used a block of wood instead.

The operation of this machine is so efficient and simple that we hesitate not in saying that we believe your keyseater to be the best on the market.

Very truly yours,
PEGLAR MANUFACTURING CO.,
per D. C. Peglar, G.M.

DCP/B

Note particularly that the machine mentioned herein is 16 years old.

After all, a manufacturer, is or should be, proud of his product. But, sometimes his claims are discounted to allow for what is termed his "enthusiasm."

Read this testimonial for the

CATLIN Key Seater

It was unsolicited. Is it not as "enthusiastic" as any assertions we have made?

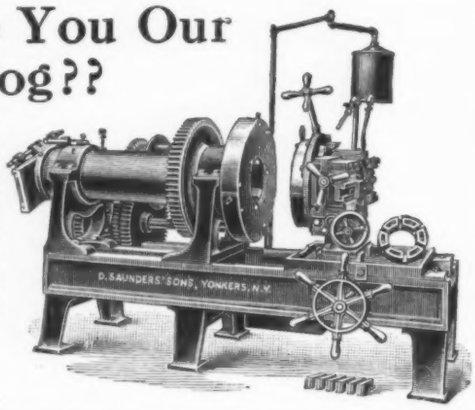
It should convince every progressive machine shop owner, manager, superintendent, foreman and mechanic of the efficiency of the Catlin Key Seater.

It should cause him to send for Catalog "B." This will tell him about the time-saving qualities of the Catlin. Write.

Chattanooga Machinery Co.
Chattanooga Tenn.

Have You Our Catalog??

If not, write us asking for Catalog "M"— a book describing in detail the many superior points regarding our famous line of **Pipe Cutting and Threading Machines.** We illustrate our No. 6 with patent adjustable expanding die head with interchangeable chasers.



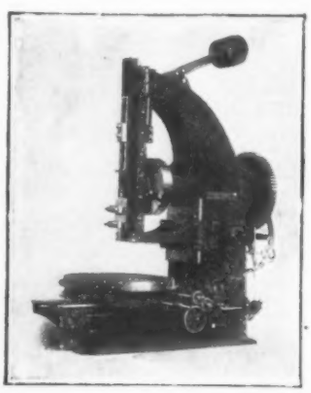
D. Saunders, Sons, Yonkers, N. Y.

PIPE MACHINES

Peerless, P.D.Q.C. and Duplex

The Peerless Adjusting Mechanism is the feature of the die-head. Simple to adjust, and when set for a size, stays set until you want it changed. **Send for catalog.**

Bignall & Keeler Machine Works
Edwardsville, Ill.



William Sellers & Co. Incorp.
Philadelphia, Pa.

STABILITY—ACCURACY—RAPID MANIPULATION

The design and construction of our Slotters embody in the highest degree these features which are essential to the production of the best and largest output. 125 Sellers Slotters to the Baldwin Locomotive Works in 11 years.

LABOR SAVING MACHINE TOOLS SHAFTING INJECTORS

Keyseating attachment for drill press

One of the most useful, simple tools ever devised for shop use. Particularly handy on unusual and difficult jobs which are impossible or hard to reach with chisel, lathe or planer.

NATIONAL Keyseating Miller

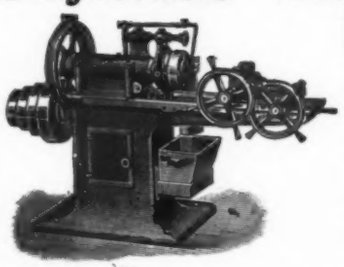
Over 5000 in use. Made in 25 different diameters ⅝" to 3½". Used with bushings there is no limit to the variety of work possible.

By all means get our Booklet D.

National Machine Tool Company

2270-2272 Spring Grove Ave., Cincinnati, Ohio

Adjustable While Machine Is Running



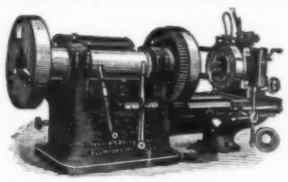
The die head of Acme Bolt Cutters is furnished with our latest improved die adjustment, consisting of a micrometer screw just over the die head.

By means of this, adjustment may be very exact and yet readily made while machine is running.

For details and descriptions of our complete line, get our Catalog.

The Acme Machinery Co., Cleveland, O., U. S. A.

Messrs. C. W. Burton, Griffiths Co., London, England. Messrs. Schuchardt & Schutte, St. Petersburg, Russia; Berlin, Germany; Stockholm, Sweden. Alfred H. Schutte, Milan, Italy; Brussels, Belgium; Paris, France; Liege, Belgium; Bilbao, Spain; Barcelona, Spain; Lisbon, Portugal; Cologne-Deutz, Germany. Schuchardt & Schutte, Vienna, Austria, and the Balkan States.



PIPE THREADING MACHINERY.

Hand Stocks and Dies.
Pipe Cutting Off Machines.
Pipe Couplings for Gas Lines.

Standard Engineering Works

Ellwood City, Pa., U. S. A.
1012 Chemical Bldg., St. Louis, Mo.

Send Us Your Inquiries for

BOLT, NUT, FORGING AND WIRE NAIL MACHINERY

THE NATIONAL MACHINERY CO. TIFFIN, OHIO, U.S.A.

Accurate Rapid Key Seating
The GIANT

Cuts more keyways per hour than any other machine. May be adjusted over a wide range of work in either straight or tapered bores.

Write for catalog today.

MITTS & MERRILL, 913 Tilden Street, Saginaw, Mich.

The Groos Metal Shear

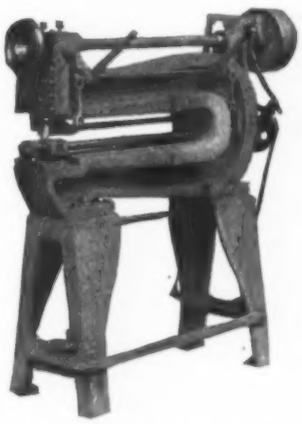
Cuts ⅛" Sheet Steel, any width or length, weight 14 lbs., Steel drop forgings throughout. Vanadium Steel blades.

$7.50 delivered to any part of U. S.

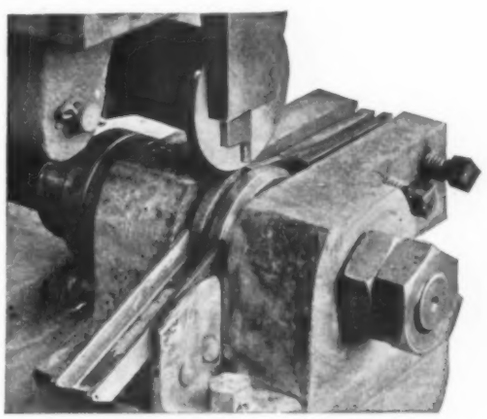
CHICAGO PATENTED TOOLS CO.,
1605 Owen Avenue, Racine, Wis.

GRAY'S
Sheet Metal Cutter No. 1
(Patented)

***Not** a Rotary Shear*



This Machine with *Cutting Mechanism* like this



will execute work like *this.*

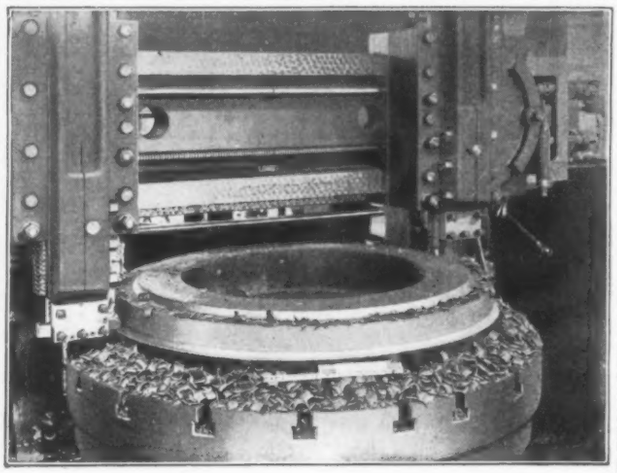
Steel Plate 10"x18", 3/16" thick.

Cut in any conceivable shape. Stock left in *perfectly flat* condition.

Write for Detailed Information.

MANUFACTURED BY

W. J. Savage Co., Inc.
Knoxville, Tenn.



On the Colburn

There's lots of interest in this picture for prospective boring mill buyers.

This cast iron ring is 44″ in diameter.

There's a cut on the rim and one across the top. Together they are removing cast iron at the rate of 1,400 lbs. per hour.

Some speed, eh? Nothing unusual, though, when you know the Colburn.

Six sizes of Colburn Mills. **Bulletins on request.**

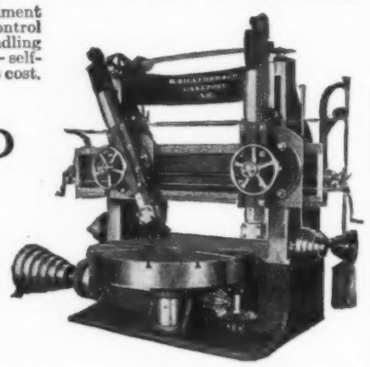
Colburn Machine Tool Co.
Franklin, Pa.

Complete within itself

no extras no extra cost

This is notably a non-attachment mill. Every adjustment, control and automatic feature for handling most difficult work, *built-in* — self-contained. Consequently less cost.

The BICKFORD



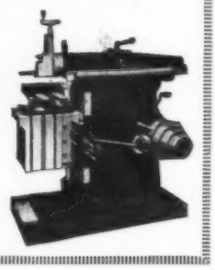
A mill of superb strength and power, absolute rigidity and proverbial accuracy. Does what other machines can't. Handles regular run work to suit the most exacting quality and quantity shops alike. The catalog is interesting.

H. Bickford & Co.
Lakeport, N. H., U. S. A.

Your Shop Policy Should Be

more work, better work, less cost. Take small parts off planers and put them on Steptoe Shapers with their quick stroke and absolute accuracy.

Take your small milling jobs to a Steptoe Hand Miller, that can be handled so quickly that it will produce more of them. Made with lever or screw elevation to knee.



THE JOHN STEPTOE COMPANY
Northside Cincinnati, O.

Railroad Shop Equipment

Special Railroad Draw-Cut Shapers furnished with full equipment and attachments for machining Locomotive Axle Boxes. **36-inch Stroke. Traveling Head Draw-Cut Cylinder Planers** with full equipment. **Write for Bulletins.**

Morton Mfg Co., Muskegon Heights, Mich., U. S. A.

"Cleveland" Open Side Planers

for simplicity without a single sacrifice. YOUR REQUEST brings the descriptive CATALOG.

See first issue of each month for illustrations.

CLEVELAND PLANER WORKS
Cleveland, Ohio

"STOEVER" PIPE MACHINE

The machine with 25 per cent. greater capacity, size for size.

TREADWELL ENGINEERING CO.
88 West Street New York

PLANERS

Send for Bulletins.

Woodward & Powell Planer Co.
WORCESTER, MASS.

KELLY SHAPERS

Have the advantage of being the sole machine tool product of an organization of specialists. They possess correct design, unusual accuracy and are easy to operate. Three sizes single geared, four sizes back geared. **Write for a Catalog.**

THE R. A. KELLY COMPANY, Makers of Shapers only for 25 years
P. O. BOX 488 XENIA, OHIO, U. S. A.

We are manufacturers of Lincoln Type Milling Machines, Bench Milling Machines, Hand Milling Machines, and a line of reliable Screw and Lever Vises. Get our circulars and prices.

The Carter & Hakes Machine Co., Winsted, Conn., U. S. A.

SHAPERS

Smith & Mills Company, Cincinnati, Ohio, U. S. A.

Foreign Agents—C. W. Burton, Griffiths & Co., London. G. & F. Limbourg, Freres, Brussels. Van Reitschoten & Houwens, Rotterdam. Gleanzer Perreaud & Thomine, Paris. Stussi & Zwiefel, Milan.

"OHIO" SHAPERS

PLANERS 22″ x 22″ to 42″ x 42″. SHAPERS 14″ to 28″.

THE OHIO MACHINE TOOL CO., Leighton St., Kenton, Ohio, U. S. A.

Those tools won't need grinding so often if you use

GERMANIA LUBRO COMPOUND

THE machines won't become clogged up or rusted. The lathes will run as evenly and smoothly as the most exacting could wish for. The stops will stay clean.

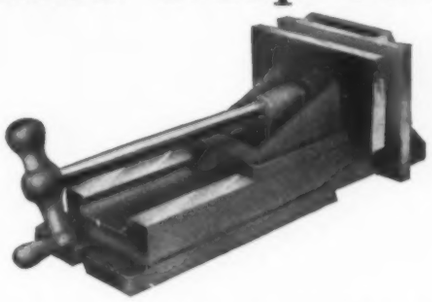
Germania Lubro Compound

never cuts the bearings, and obviates the necessity of taking turrets apart. There is just enough lubrication in it to assure no gripping of running parts. Other lubricating oils aren't cut by this compound.

But write us for information applying to your particular case. You might ask for Bulletin No. 8, too. It's mighty interesting.

Oil City Oil and Grease Co.
Oil City, Pa.

These Deep Jaws



with their side overhang are ideal for holding those troublesome long, upright pieces for drill press or other work.

No machine shop should be without

The MARVEL Drill Press Vise

Consider the time saved alone by the quick-acting, sliding jaw in setting the work.

Can you *afford* to wait?

Two sizes: 5″ and 8″ jaw openings. Price $9.00 and $11.00 net, f. o. b. Chicago, Ill.

Order now or write for Catalog.

Armstrong-Blum Mfg. Co.
347 N. Francisco Avenue **Chicago, Ill.**

DIXON'S FLAKE GRAPHITE

The perfect lubricant for machine tools, because it cannot run out or squeeze out or work out of the bearings. Send for Booklet No. 4.

Made in JERSEY CITY, N. J., by the
JOSEPH DIXON CRUCIBLE COMPANY
Established 1827

The Highest Award

at the Panama-Pacific International Exposition, the gold medal for vises, has been awarded to

Reed Vises

This is merely expressive of what has long been fact in the opinion of Reed users. They know that whether competing under the scrutiny of official judges, or whether the test is under the trying conditions of heavy shop usage, the Reed always wins. **Write for catalog.**

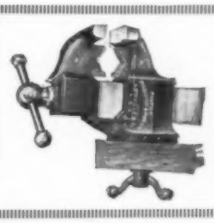
Reed Mfg. Co.
Erie, Pa.

New oil from old oil ——— New waste from waste waste

no more than a trace of oil remains in oily-chips after passing through this machine. Same is true of waste. The reclamation in both cases is the limit of mechanical possibilities. ¶ Centrifugal; direct steam turbine drive. Quadruple capacity of belt driven machines. Quicker, better; more easily charged and discharged; less driving power; longer life. Every possible feature for ease in handling. **Write for full data.**

Savoil Separators

Oil & Waste Saving Mach. Co., Real Estate Trust Bldg., Phila., Pa.



The Star Combination

This combination Machinist's and Pipe Vise has ample weight and strength and is fitted with removable pipe jaws. These jaws are made of a special grade of steel and will give maximum service. Write for our new booklet "Vises."

Fulton Machine & Vise Co.
101 West St., Lowville, N. Y.

Scientific Cutting Lubricant

Aqualene
TRADE MARK REG.

Greater Feeds. Speeds!

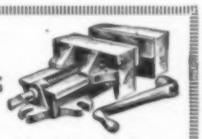
Write for Bulletin A-30.

Crescent Oil Co., 30 Church St., N. Y.

VISE

For Your Driller, Miller, Shaper or Planer—3 Sizes

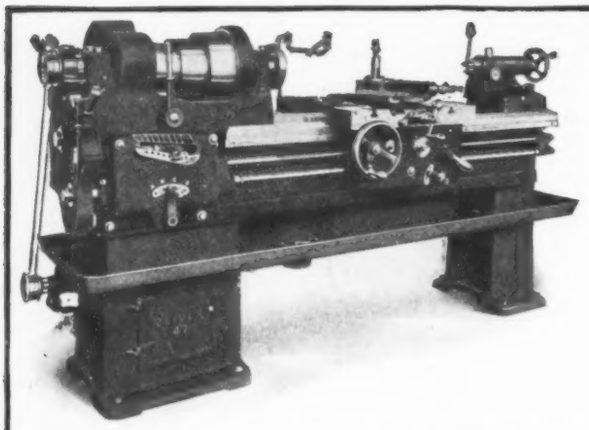
Our Other Tools—Drill Speeders and Knurl Holders



With Jig Attachments *Without Jig Attachment*

THE GRAHAM MFG. CO., **Providence, Rhode Island**

Germany, Austria, Scandinavia, A. Kayser, Berlin, France, Italy, Spain, Holland, Belgium, Fenwick Freres & Co., Great Britain, C. W. Burton, Griffiths & Co.



The "Oliver" 16-Inch Heavy Duty

ENGINE LATHE

POWERFUL
DOUBLE BACK GEARED
QUICK CHANGE GEARS
THREAD CUTTING

EARLY DELIVERIES

WE SPECIALIZE ON THE ONE SIZE—A QUALITY TOOL

Write for ENGINE LATHE BULLETIN.
Write for TURRET LATHE BULLETIN.

Oliver Machinery Company
Grand Rapids, Michigan, U. S. A.

LATHES

That stand for large and accurate production.

12″ Gear Box Lathe

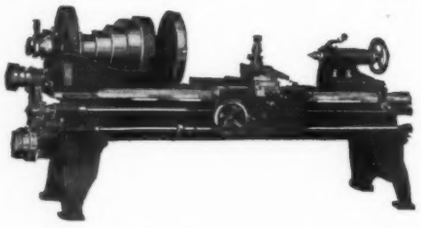
DAVIS

lathes are carefully and accurately made for the most exacting work of the modern machine shop.

WRITE FOR PARTICULARS ON OUR 12″, 14″, 16″, 18″ and 22″ LATHES.

DAVIS MACHINE TOOL CO., Inc.
St. Paul Street Rochester, N. Y., U. S. A.

"Reed-Prentice" Lathes Are Right



The **Reed-Prentice** Line of Lathes consists of Standard Engine Lathes, Tool Room Lathes, Heavy Duty Double Back Geared Lathes, Motor Driven Lathes, Hand Lathes, Plain Turning Lathes, Manual Training Lathes. The well known **Reed-Prentice Quick Change Gear Mechanism,** the easily-adjusted **Taper Attachment, Lead Screw cut** from special lead screw steel and guaranteed for extreme accuracy, **Micrometer Dials** on rest screws, **Thread Chasing Dial, Relieving Attachment** and **Steel Oil Pan** are features of **Reed-Prentice** equipment, which make them favorites in Tool Room and Manufacturing Work.

Write for the Latest Reed-Prentice Bulletins on Lathes.

Watch for our double-page ad. next week.

REED-PRENTICE COMPANY
WORCESTER MASSACHUSETTS

24 inch Engine Lathes; 10, 12 and 14 ft. beds for early deliveries.

C. LEE COOK MFG. CO., Inc.
Louisville, - - - - - - - Ky., U. S. A.

ENGINE LATHES

18″ to 48″ Swing
THE
Bove & Emmes Machine Tool Co.
Cincinnati, Ohio, U. S. A.

CUTS OFF IN HALF THE TIME

The Hurlbut Patent Cutting-Off and Centering Machine is arranged to have two tools cutting in a single cut. This gives the capacity of two machines at the expense and in the floor space of one machine.

Catalog?

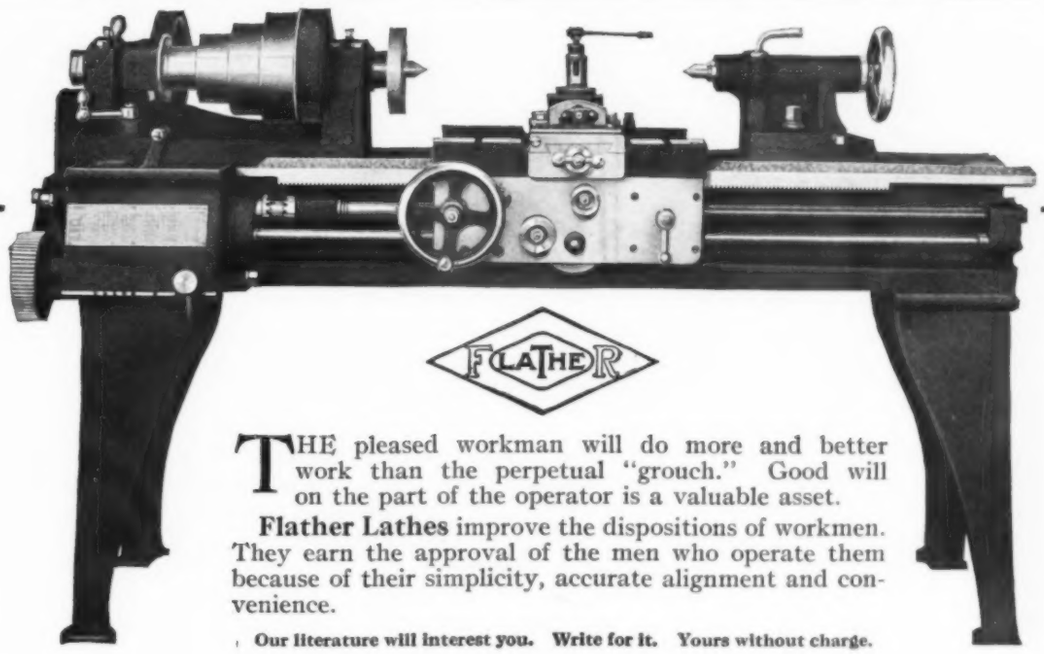
The Hurlbut, Rogers Machinery Co., So. Sudbury, Mass.

CINCINNATI LATHES

have thoroughly demonstrated in shops everywhere what we claim You take no chances now or years hence when you buy them Our **Quick Change Feed Box** gives an unlimited range to cut odd or metric threads if desired, besides the standard changes made at once *Let us figure on your requirements*

THE CINCINNATI LATHE & TOOL CO.
OAKLEY, CINCINNATI, OHIO, U.S.A.

They Help Your Men to Do Better Work



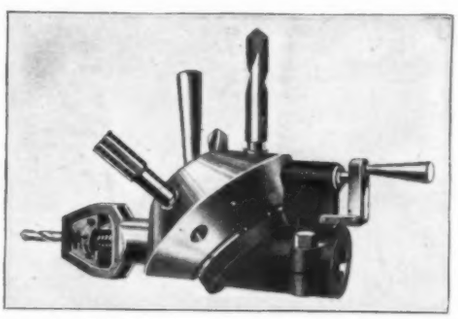
FLATHER

THE pleased workman will do more and better work than the perpetual "grouch." Good will on the part of the operator is a valuable asset.

Flather Lathes improve the dispositions of workmen. They earn the approval of the men who operate them because of their simplicity, accurate alignment and convenience.

Our literature will interest you. Write for it. Yours without charge.

Flather & Co., Inc., Nashua, N. H., U. S. A.



Why Buy a Turret Lathe? Same Results for $35.00

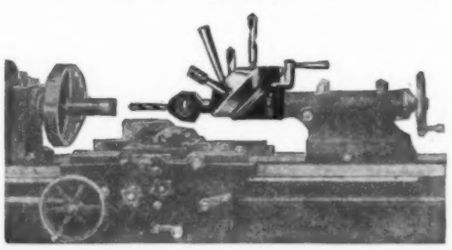
By attaching a Newman Improved Turret Head to any engine lathe you can equal the production time and quality of work done on an expensive turret lathe and screw machine.

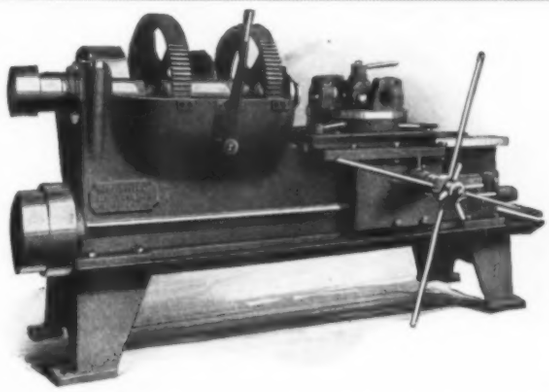
It's not a toy, but a substantial and accurate attachment that holds firm and always central.

Get one on trial. Returnable if not satisfactory.

Dealers write for proposition. Write for Circular T.

Newman Mfg. Company, Cincinnati, Ohio





It Eats Shell Work

because that's what it's made for.

The Cleveland Chucking Lathe is a powerful, massively built machine, with a simplicity of control that makes skilled labor non-essential.

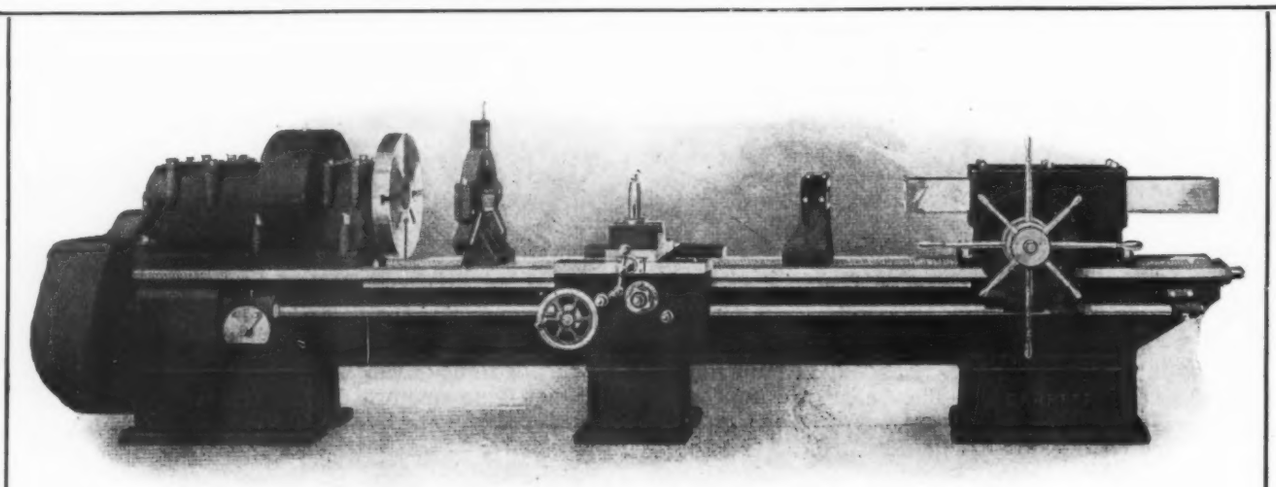
Furnished either with turret on cross slide, cross slide with tail stock, or plain carriage with turret.

Want the details?

The Cleveland Crane & Eng. Co., Wickliffe, Ohio

Barrett 25" Heavy Duty Projectile Boring Lathe

A thorough tried out proposition for boring and facing projectiles and shells, up to 12 inches in diameter. Let us send you specifications and full particulars.



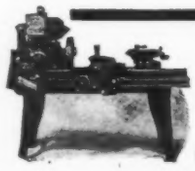
Barrett Machine Tool Co., Meadville, Pa., U. S. A.

SEBASTIAN

To secure high grade lathe results with minimum investment, choose the SEBASTIAN LATHE.

Let us send you details.

The Sebastian Lathe Co.
117-119 Culvert Street,
Cincinnati, Ohio



Monarch Lathes are the recognized leaders of all low priced Engine lathes. 14-16-18 and 20 in. sizes. Send for Catalog and prices.

The Monarch Machine Tool Co.
Sidney, Ohio

A Dependable Bench Lathe

This sturdy little bench lathe will be an asset to your shop. It is accurately constructed—head and tail stock being milled together, assuring permanent alignment. Head stock spindle is of high carbon steel accurately machine ground. Leaflet 43 describes it fully—send for it today.

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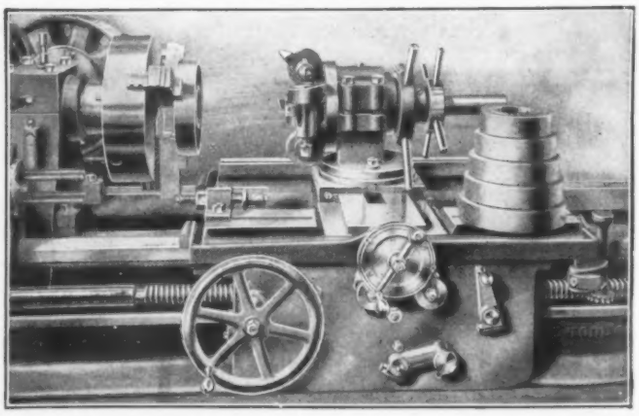

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What better combination could you ask for than low initial cost and 100% efficiency on every point?

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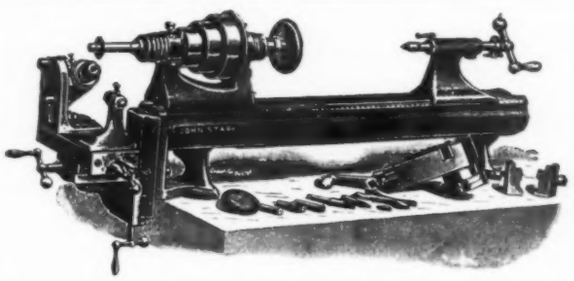

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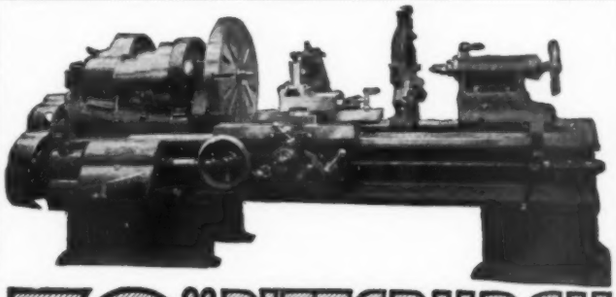

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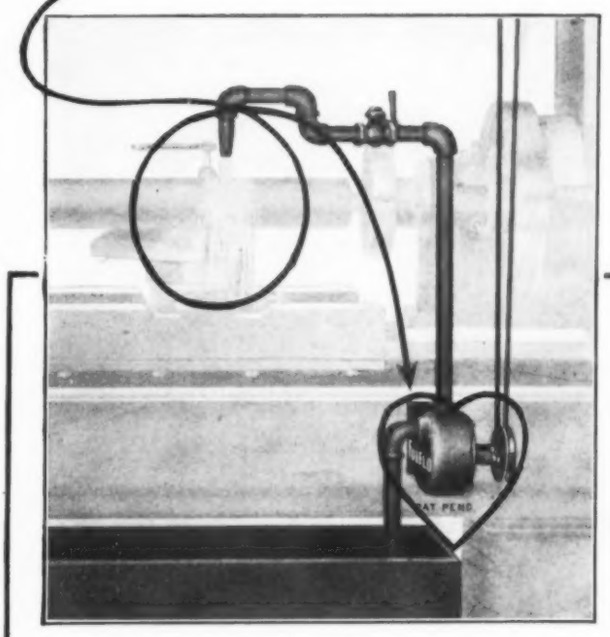

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Your machine is just as efficient as the cutting point of the tool—and no more so. If you are able to increase the cut and speed of your machine, your production will increase. To do this the tool and work must be kept cool and the

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Efficient cooling will save your valuable tool steel.

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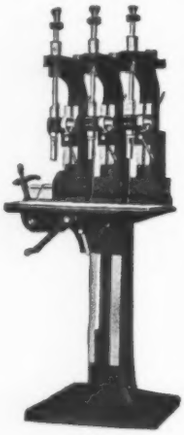

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Taylor & Fenn Manufacturers' Drilling Machines operate at a minimum labor cost in drilling holes up to ¾" diameter. They are rigid in design and will stand up under any feed. They will drill one - half inch diameter holes, one inch deep, in four seconds.

Built in **sixteen** sizes and **five** different types of drilling heads.

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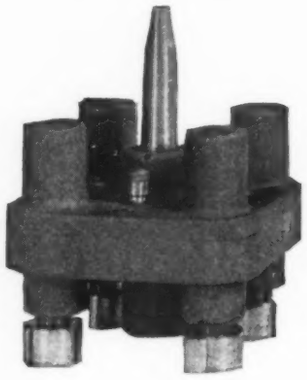

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Special Drill Heads
The type shown is being used extensively for drilling fuse plug parts
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WE make a standard line of Straight Line, Cluster and Double Auxiliary Adjustable Drill Heads.

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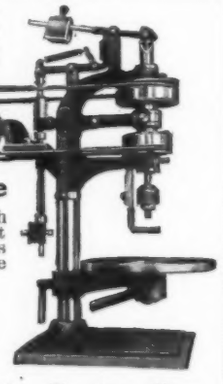

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taps either blind or through holes up to ¼ inch in diameter. An automatic stop can be set to tap to any depth desired. All end thrusts are ball-bearing to reduce friction and make machine more sensitive.

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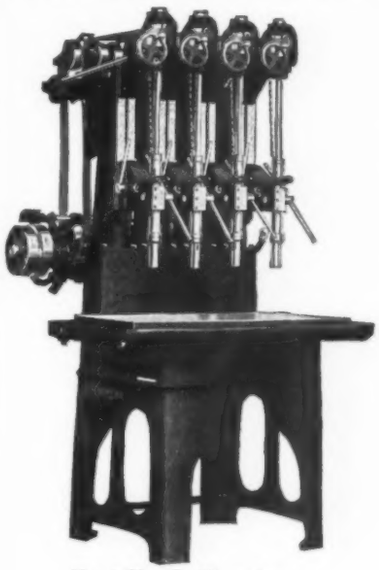

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is assured in the sensitive drilling of holes up to ¾" in diameter by

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We furnish a **free chart** containing the most economical speed and feed combinations for drilling in different metals. By following this simple guide, you can greatly increase your production and realize a considerable saving in drilling costs.

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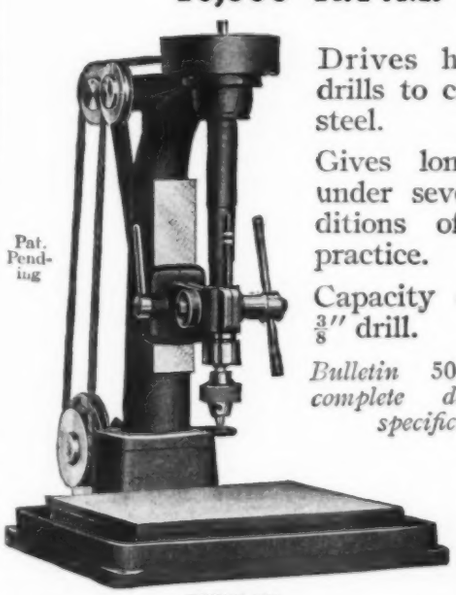

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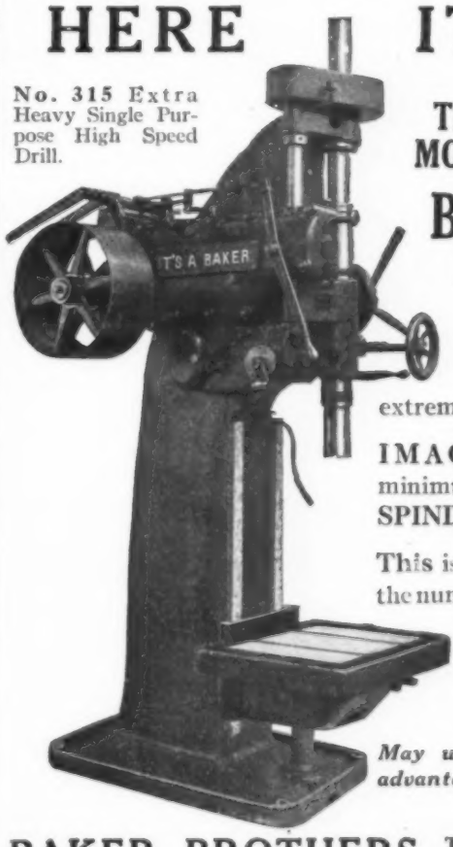

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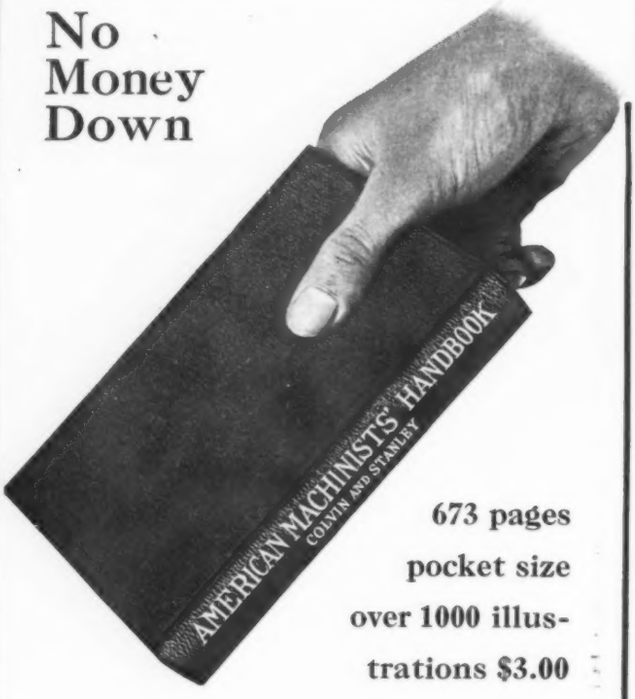

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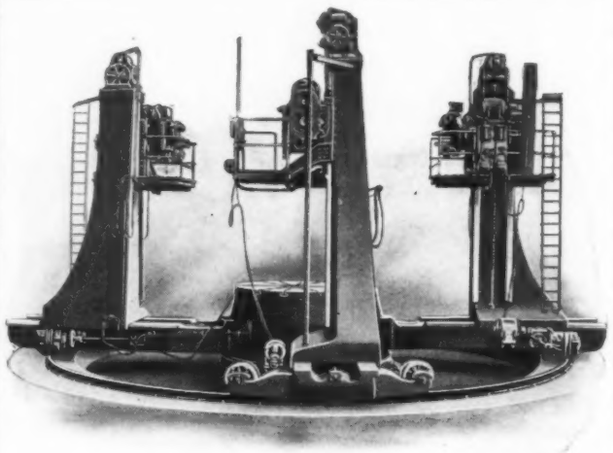

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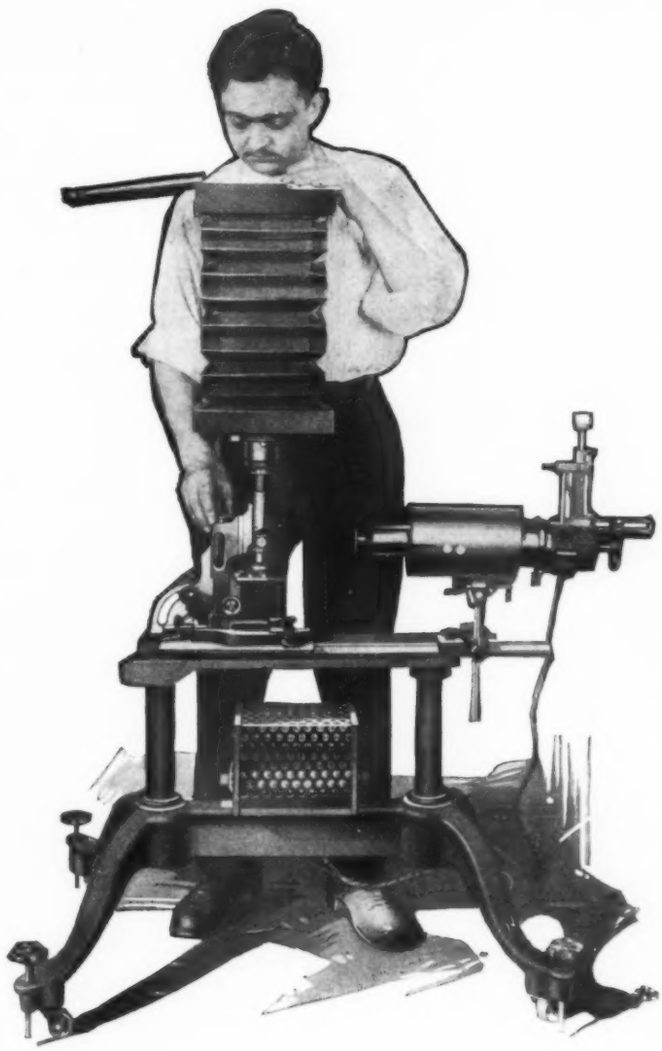

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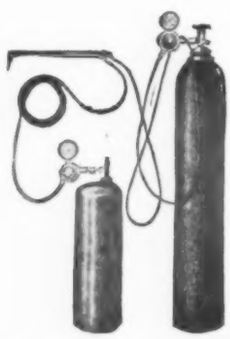

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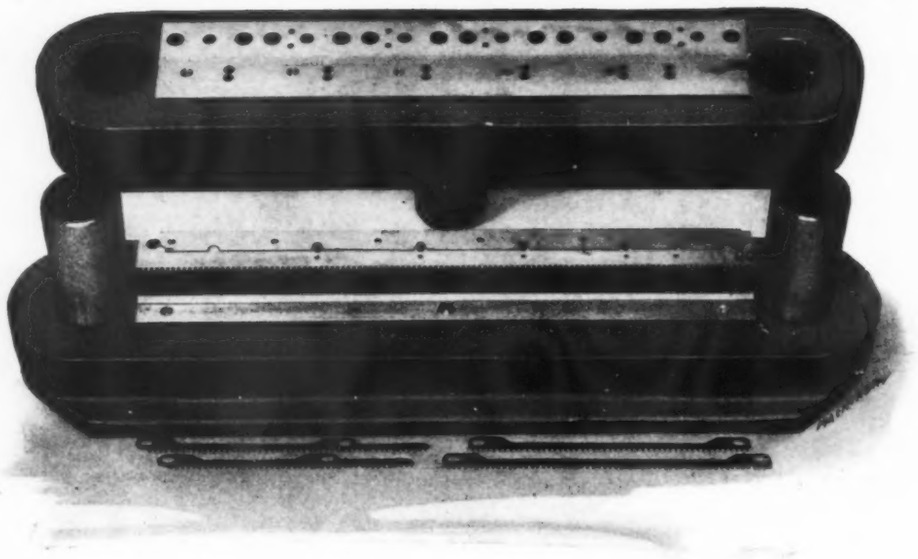

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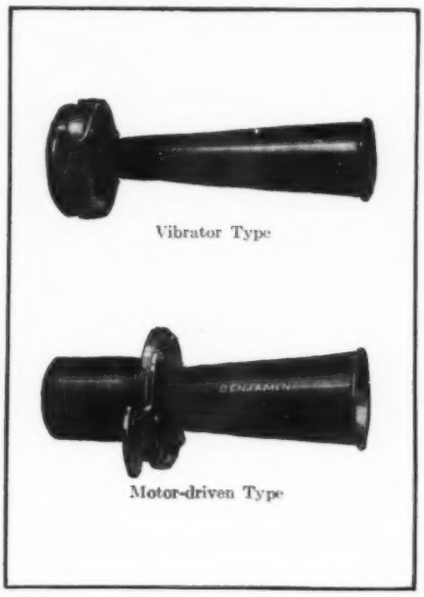

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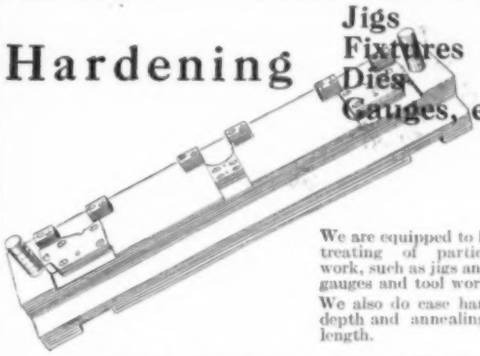

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To secure 100% Economy and 100% Efficiency, use W. N. Best oil and tar burners and furnaces for Annealing, Case Hardening, Tempering, Forging, Heat Treating, etc. Send for Catalog.

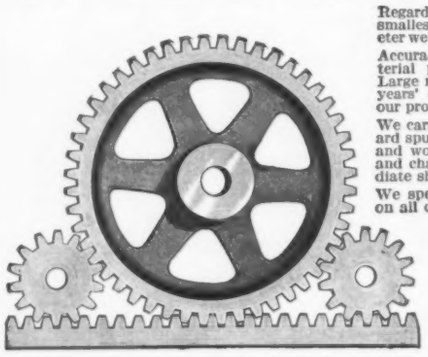
"There is nothing better than the Best."
W. N. BEST, 11 Broadway, New York City

HOBSON'S CHOICE XX EXTRA REFINED | **WARRANTED BEST CAST STEEL**

These two brands of TOOL STEEL are noted for their UNIFORMITY for Turning, Slotting, Planing, MILLING CUTTERS, FORMING TOOLS, Reamers, Broaches, Taps and Punches, Dies, etc. A large and varied stock of BARS and SHEETS for all purposes on hand. PIVOT or SCALE STEEL, DRILL ROD.

HOBSON, HOUGHTON & CO., Ltd., Sheffield, Eng. Warehouse: 83 Beekman St., New York
Western Agents: E. K. Morris & Co., Cincinnati. Hoyt-Noe Steel Co., Chicago.

IF IT'S A GEAR



Regardless of the kind from the smallest size to 6 ft. in diameter we're prepared to make it.

Accuracy and quality of material positively guaranteed. Large modern factory and 40 years' experience in back of our product.

We carry a full line of standard spur, bevel, mitre, helical and worm gearing, sprockets and chain in stock for immediate shipments.

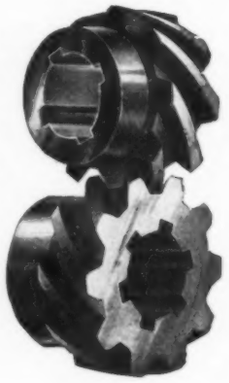
We specialize in rush orders on all classes of gear work.

Free estimate from your blueprints or sketch. Write.

GRANT GEAR WORKS, INC.
151 Pearl Street, Boston, Mass.

Living Up to the reputation

we have established for accuracy, high quality and prompt service—that's what we are doing. Gears made in our shop are the kind that give perfect satisfaction.



Let us quote you on your next gear work. Forward blueprints.

Albaugh - Dover Company
Marshall Blvd. and 21st St.
Chicago, Ill.

Phillie Gear Hires a Workman

"Are You Sure You Can Meet My Requirements?" **He Asks.**

When Phillie Gear hires a new man the applicant is put through the "third degree."

Phillie Gear cannot afford to take chances. The men he hires must be up to an unusually high standard as regards their experience, quickness and skill. They must know their business thoroughly and be proficient in every detail of the work they will be called upon to do.

Phillie Gear finds that care in engaging workmen pays. Try him on a rush order for spur gears, bevel gears, mitre, worm, spiral and helical gears or sprockets.

Philadelphia GEAR Works

Vine St. and Reading R. R., Philadelphia, Pa.

When you say

MEISEL

You mean highgrade

GEARS

Just test this out by placing a trial order with us. Heavy pitch spur gears and sprockets; helical, herringbone, bevel, worm and internal gears and racks a specialty.

Furnish us blueprints to quote on.

Meisel Press Mfg. Co.
946-950 Dorchester Ave., Boston, Mass.

Micarta Gears

Tougher, Stronger, Wear Better Than Rawhide

We will fill one trial order for you on the guarantee that if Micarta does not wear twice as long as Rawhide in the same service, we will **refund** the difference in price.

Nuttall—Pittsburgh

Clutch Gears. A kind of work that is easy for us.

'Any Old Gear' Won't Do Everywhere But New Process Gears and Pinions Will

You get more than mere material and machine work when you buy New Process Gears and Pinions. You get correct tooth design, right machining methods, judicious selection of metal and the careful finish essential to permanently satisfactory service.

The men responsible for our output have designed, have sold, have studied, have lived with and loved gears as an exclusive product during the last 25 years.

And our equipment includes every desirable special tool for quality and quantity production of spurs, bevels, spirals, worms, internal and external, and of any material.

We further have the desire and experience to help in choosing for given requirements—a service offered without one cent of added expense.

One order would prove to you that New Process Gears and Pinions are reasonable in price and genuinely good.

Send your prints or specifications for figures.

YOU CANT PUT YOUR GEAR WORK INTO BETTER HANDS

N.P.R.H. REG U.S. PAT OFF

NEW PROCESS GEAR CORPORATION

SYRACUSE, N.Y.

N.P.R.H. REG U.S. PAT OFF

91

Top-Notchers

This applies to gears leaving our shop.

Our gear shop is especially equipped to supply you with a top-notch class of work. We have every facility that money can buy to insure speed and quality.

If it's Bevel Gears, Mitre Gears, Spur Gears, Internal Gears, Worms and Worm Wheels, Rawhide Gears or Spiral Gears, *write for Catalog "C."*

The Cincinnati Gear Company
1825-27-29-31-33 Reading Road, Cincinnati, Ohio

A Sidelight on "V. D. & D." Gears

Down in Ohio there is a little manufacturing town that for a number of years we forgot was on the map. Other gear makers had been calling there continually and likewise sending their advertising literature.

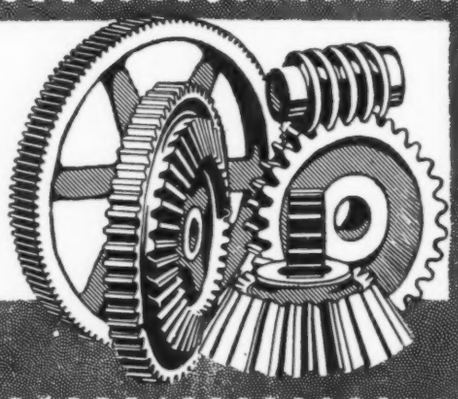
What woke us up to the fact that we were overlooking something was an order that came into our office one morning. "Please make up such and such "V.D. & D." gears just like those you made for us five years ago."

We couldn't understand at first why they hadn't forgotten us. Perhaps they had. But of course our trade mark was still on their old gears.

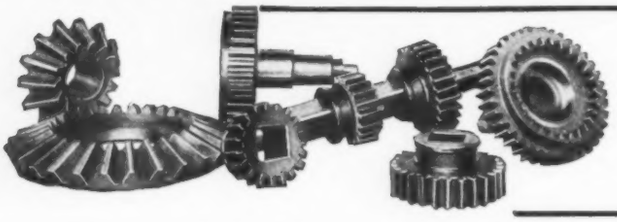
It isn't Advertising or Selling. "V.D. & D." Gears sell themselves.

We have an instructive book which we shall be glad to send you. Write for "Gears and Gear Cutting."

BRANCHES: Baltimore Atlanta Denver Salt Lake City



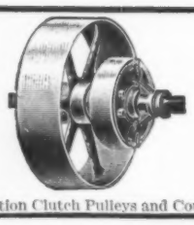
THE VAN DORN & DUTTON COMPANY.
GEAR SPECIALISTS
NEW YORK CLEVELAND SAN FRANCISCO



Gears for Hard Service

Hardened by our methods will satisfy you. Manufacturers of Cut Gears, all sizes. Spur and Worm Gear Reducers. **Send for 240-page Catalog.**

Foote Bros. Gear & Machine Co.
210-220 N. Carpenter St., Chicago, Ill.
Specialists in heat-treated gears for tractors and trucks.

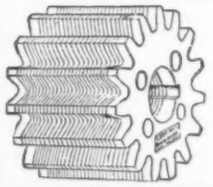


Friction Clutch Pulleys and Couplings

THE A. & F. BROWN CO.
ENGINEERS, FOUNDERS, MACHINISTS AND MILLWRIGHTS
79 BARCLAY ST., NEW YORK
POWER TRANSMISSION MACHINERY
ROPE DRIVES A SPECIALTY. TURNED STEEL SHAFTING
WE LAY OUT, MAKE THE DRAWINGS, FURNISH THE MATERIAL AND ERECT IT
SEND FOR CATALOGUE WORKS—ELIZABETHPORT, N. J.

Gears of all kinds and sizes

M-C GEARS
are accurately generated on our hobbers.
Let us cut your gears.
Meisselbach-Catucci Mfg. Co.
28 Congress Street Newark, N. J.



Chicago-Rawhide Pinions
The best that selected material and careful workmanship can produce
The Chicago Rawhide Mfg. Co.
1301 Elston Avenue, Chicago, Ill.

SPUR AND BEVEL GEARS
Let us figure on cutting your gears or on the equipment for doing the work yourselves
FLATHER AUTOMATIC GEAR CUTTING MACHINES
are accurate, rigid and economical.
E. J. FLATHER MFG. CO. NASHUA, N. H., U. S. A.

Rawhide Gears
Manufactured by
The Horsburgh & Scott Co.,
Cleveland, Ohio

Father Time Blunts His Scythe on FABROIL GEARS

Fabroil Gears never have to be guarded against deterioration by long storage. They stand the ravages of time, the sizzling heat and freezing cold, the dampness, dryness and humidity which are all so injurious to other non-metallic gears.

This means that you can lay in a stock of **Fabroil Gears** against the sudden emergency when you may need a gear in a hurry and haven't time to waste in ordering.

Strong, silent-running **Fabroil Gears** last long in actual service, proving more durable than cast iron or brass. Thus, whether you use them or let them wait on your shelves, Father Time blunts his scythe when he attempts to mow them down.

General Electric Company

General Office, Schenectady, N. Y.

Sales Offices in all large cities

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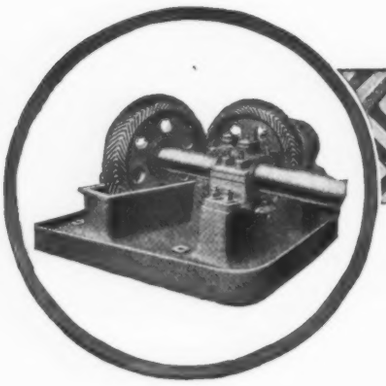


CITROËN GEARS

For Silent Back Axles

Silent
Strong
Efficient

Prompt
Delivery

The Citroën Gear Co.

Sole Manufacturers

General Offices and Works **Paris (France) 31 Quai de Grenelle**

TWISTED ROUND BELT-LACING

Makes a strong and durable joint and runs as perfect as the lap. There is a reason why you will eventually use it; send for a sample joint (for inspection).

It is all in the twist.

GEO. W. SOUTHWICK CO.
STAMFORD MANUFACTURERS CONN.

Sawyer Gear Works

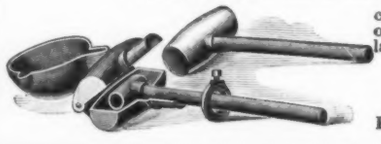
5122 St. Clair St., Cleveland, Ohio

Gears (of all *kinds* and sizes in stock and made to order.

From the cheapest that's *good*
To—the *best* that's made.

Sample our workmanship. Get our prices.

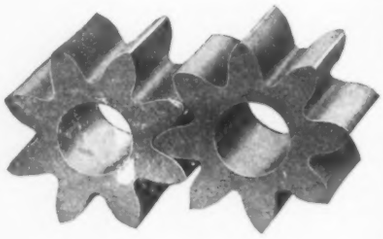
Soft Metal Hammers and Vise Jaws



can be poured by a boy with our combination mould and ladle. A great money getter.

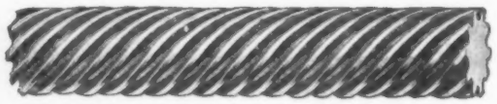
Particulars and prices on request.

Charles H. Field
Providence, R. I.



STEEL GEARS
SPROCKETS AND PINION WIRE

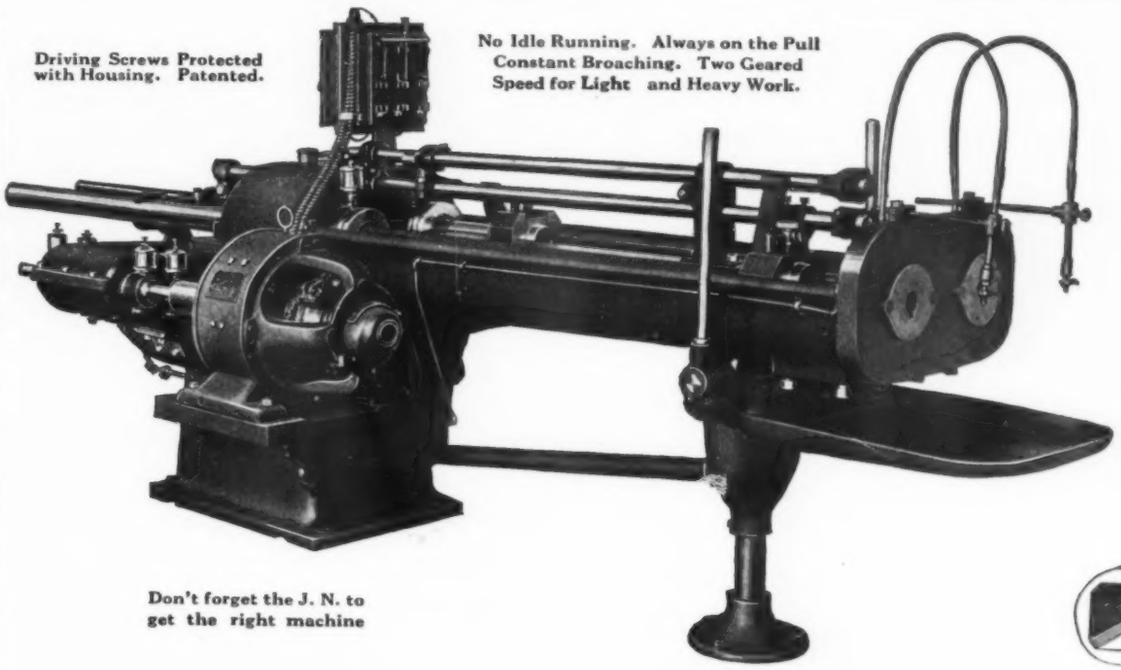
Accurate enough to fill any requirements and at prices which should bring your work to the



Boston Gear Works
Norfolk Downs, (Quincy, Mass.)
Send B/Ps for Estimates.

Driving Screws Protected with Housing. Patented.

No Idle Running. Always on the Pull
Constant Broaching. Two Geared
Speed for Light and Heavy Work.



Specialists on BROACHING TOOLS

Write for information and particularly Catalog

Don't forget the J. N. to get the right machine

Our Famous Double No. 2 Broaching Machine. We Manufacture one of the Most Complete Line of Broaching Machines in the world.

J. N. LAPOINTE CO. **New London, Conn.**

Fawcus Machine Company
PITTSBURGH, PA.
Gears of all descriptions to 24 feet diameter. Heavy machinery designed and furnished for all purposes.
Works: Ford City and Pittsburgh, Pa.
Main Office - - - Pittsburgh, Pa.

NEWARK G.C.M. Co.

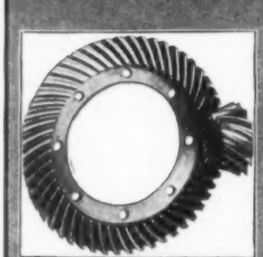
AUTOMATIC GEAR CUTTING MACHINES FOR ALL REQUIREMENTS

NEWARK GEAR CUTTING MACHINE CO.
69 Prospect St., Newark, N. J., U. S. A.

EMPRESS
OIL AND GREASE CUPS
BOWEN MFG. CO., AUBURN, N. Y.
Catalog "H" on Application

SPIRAL TYPE BEVEL GEARS

THE LATEST IN AUTOMOBILE DRIVES



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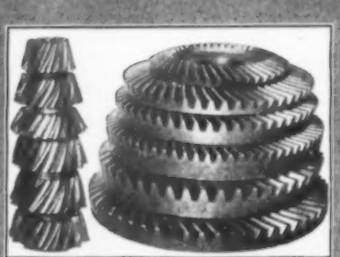
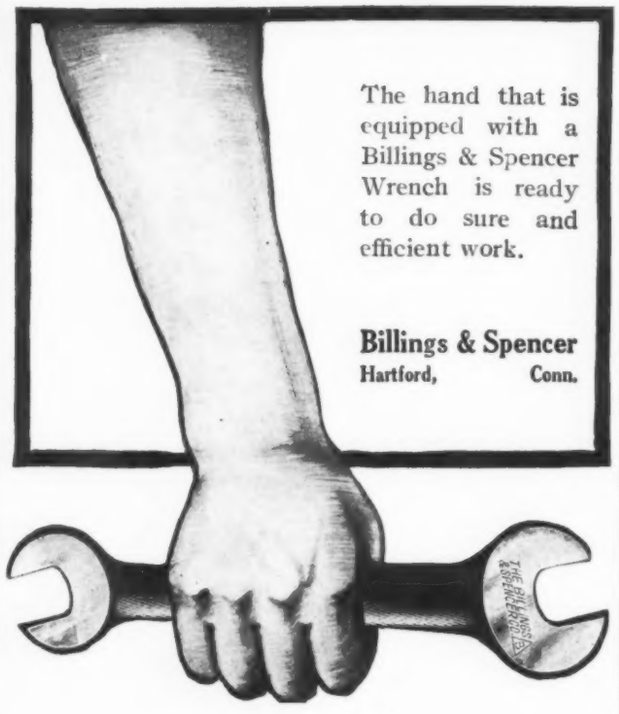
MANUFACTURERS OF GEARS AND BEVEL GEAR CUTTING MACHINERY
ROCHESTER, N. Y.



"B&S" Tools



The hand that is equipped with a Billings & Spencer Wrench is ready to do sure and efficient work.

Billings & Spencer
Hartford, Conn.

TESTING APPARATUS.
Making Sure of Quality

Pyroscope (Temperature Tester)

There is only one way to make sure of quality in the materials you buy, and in the products you sell—that is to *test* them. The two instruments shown herewith are the simplest and most economical for their respective purposes.

To determine how hard or tough is any metal—what is the resistance to wear or shock—you need the Shore Scleroscope.

For control of tempering, annealing or any other heating operation, the Shore Pyroscope is the practical device.

Write today for booklets fully describing the uses and benefits of these instruments.

Shore Instrument & Manufacturing Co.
555-557 W. 22nd St. New York

Foreign Agents—Coats Machine Tool Co., Caxton House, Westminster, London. Schuchardt & Schutte, Tokyo, Japan.

Scleroscope World Standard (Hardness Tester)

Speeding Up On Rush Orders

Accuracy is not sacrificed and the utmost convenience is retained when you use the Randall & Stickney Indicator C Dial Gauge.

This gauge sets a new price standard for these appliances. The tax is but $7.00 and the gauge is fully guaranteed to be a high grade genuine Randall & Stickney product.

It is useless to try to describe the many features of convenience in this space.

Write now for special circular "C."

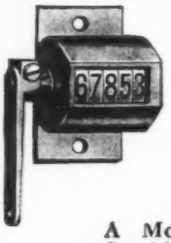
Randall & Stickney
Waltham, Mass.

Stewart Counters
WARNER Cut-Meters and Tachometers

Used for hundreds of purposes. Built to fit any machine, and to cover every requirement. Send for literature, stating your needs.

Stewart-Warner Speedometer Cor'n, Chicago, U.S.A.

Why Spend the Time to Count,
Weigh and Measure Goods by Hand



CUT LABOR COSTS BY USING

Veeder COUNTERS

A Model for Every Purpose.
Send for Our Booklet—It's Gratis.

THE VEEDER MANUFACTURING CO.
15 Sargeant Street, Hartford, Conn., U. S. A.
Makers of Cyclometers, Odometers, Tachometers, Tachodometers, Counters and Fine Castings

Time is the Chief Commodity

The amount of cash paid for labor and service on a time basis exceeds that paid for any other article of merchandise in the markets of the world. And yet there is no other item of commerce so carelessly weighed or measured.
Also, there is no other article of value so recklessly wasted.

The Calculagraph

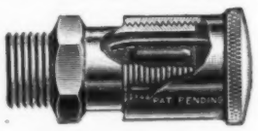
is a scientific instrument for measuring and recording time. It records *elapsed time* (actual working time)—the time you sell or pay for.
Used in your factory it will insure accuracy and save a lot of money. Our booklet, "Accurate Cost Records," tells about it.

Calculagraph Company
1438 Jewelers Bldg., New York

Get a Sample Cup—Free

Tell us your needs. We'll send a cup best suited to your needs. It'll be free. No obligation on your part. Get a sample cup, and

Get our illustrated catalog.

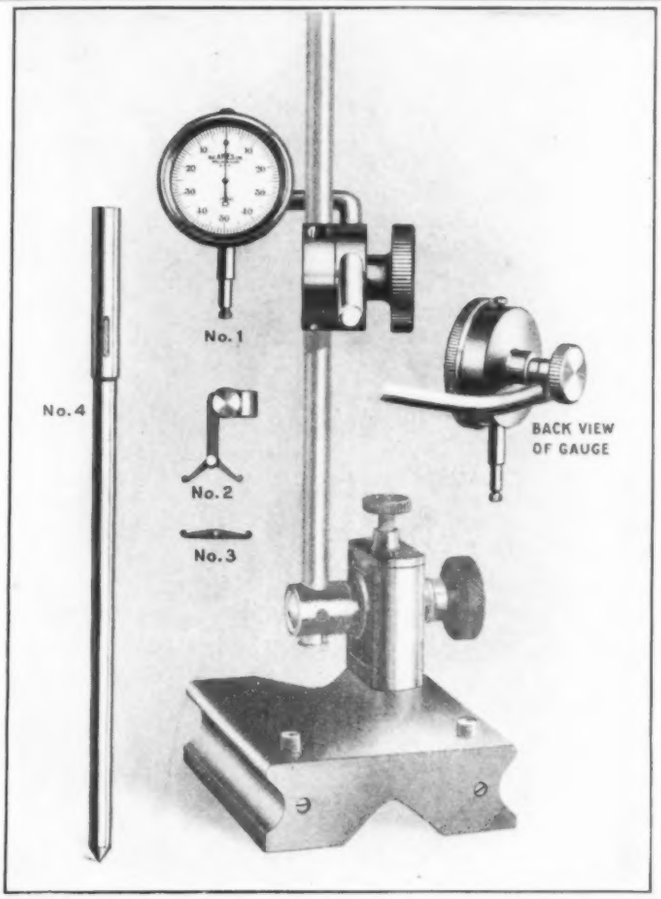


Bay State Stamping Co., Worcester, Mass.

Count Strokes or Revolutions "STERLING" COUNTERS

Their keynote is durability and accuracy. A Counter for every purpose. Let us send you details and our Illustrated Catalog No. 12.

New Haven Trolley Supply Co., New Haven, Conn.



BC AMES CO
WALTHAM MASS. U.S.A.

Dial Toolmaker's Testing Gauge (No. 22)

Widely Adaptable
Can Be Used in Any Shop

Gauge can be used with surface gauge base, 5/16 in. or 3/8 in. stem, and its accuracy and speed recommend it as a cost reducer; when used on a surface plate it makes a very universal tool in laying out jigs and fixtures, testing duplicate pieces for thickness, etc.

With this gauge machine tools can all be tested, the bearings, spindles, slides, holes or centers. On the planer or flat grinder, pieces can be made to a required thickness without removing from platen to measure.

Dial Gauge Nol 22 is graduated to read to .001 in. Dial Gauge No. 22-A is graduated to read to .01 mm.

Write for Catalog which gives complete description.

B. C. Ames Co., Waltham, Mass.

Manufacturers of

Bench Lathes, Bench Milling Machines and Dial Gauges

To Make Scientific Instruments

Firms in a position to manufacture the metal parts of instruments, please write immediately detailing manufacturing equipment and experience. *W.868—American Machinist.*

Delivering the Goods-|-

Attach **Root Automatic Counters** to your producing machinery and they **deliver** the goods **counted**—that's "delivering the goods plus" because

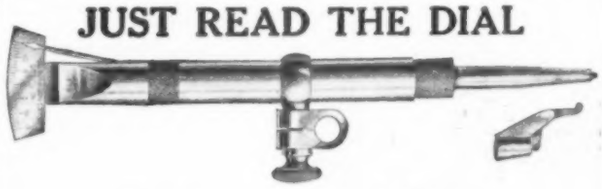
The Root Counters

protect against getting under or over-production. They are accurate, reliable and durable. Guaranteed for 3 years. We'll let you try them free. **Send now for illustrated catalog No. 17.**

The C. J. Root Co., 100 Stone St., **Bristol, Conn.**

See our Exhibit at Hardware Exchange, Broadway and Murray St., New York.

JUST READ THE DIAL



The Improved Test Indicator

Instantly detects the slightest variation from a true surface. Easily clamped to the binding post of a standard surface gauge and operates in any position. Equipped with reversible dial, graduated in both Metric and English readings. Dial may be set at any desired position. Low in price. Many have been sold on *repeat* orders. FULLY GUARANTEED. For sale at your Tool Dealers—ask to see them.

Write today for circulars and full particulars.

C. E. Robinson Co., Orange, Dept. W., Mass.

Price $2.00

Exact Size Reed & Prince Micrometer

Reed & Prince 1-inch and 2-inch Micrometers are cheap enough to wear out on the work that is hard on tools and then buy new micrometers.

The Automatic Screw Machine is hard on tools and on this job nothing can keep oil and dirt out of micrometers.

When constant use in oil and chips wears out your micrometer you surely can afford to buy another Reed & Prince $2.00 Micrometer. You'll always get more than double value in service.

Look them up at your nearest dealer's.

Write Today

for our illustrated catalog, showing our complete line of Micrometers, Screw Gages, Taps and Dies, Slotting Cutters, Machine Screws, Cap and Set Screws, Bolts, Nuts, etc.

Reed & Prince Mfg. Co.
Worcester, Mass.

Quality

Hack Saws

Send for complete catalog showing both styles, non-breakable and "all hard"

Quality Saw & Tool Works
Springfield, Mass.

The
HIGLEY
Cold Metal Saw

Catalog will be sent on application to

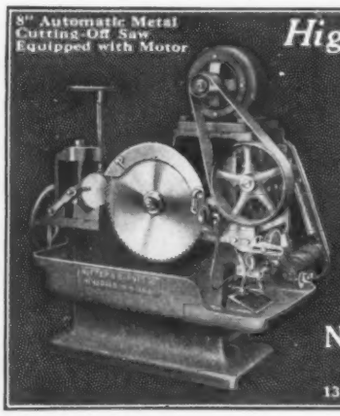
Vandyck Churchill Company
93 Liberty Street, New York

Motor or Belt Drive

Shop conditions or personal preference generally determine the drive, but in either case Lea-Simplex production and quality remain the same. Send for booklet showing exactly what these high speed, money saving tools can do.

Earle Gear & Mach. Co.
10 E. Wyoming Ave., Phila.

8" Automatic Metal Cutting-Off Saw Equipped with Motor



High Speed Metal Cutting-Off Machinery

Powerful, Automatic Cold Metal Sawing Machines for cutting bar stock 0" to 10"

Four Sizes
Also Saw and Cutter Sharpeners

Details in Catalog No. 4.

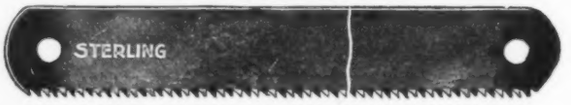
Nutter & Barnes Co.
Hinsdale, N. H.
13 So. Clinton St., Chicago

Let This Penetrate

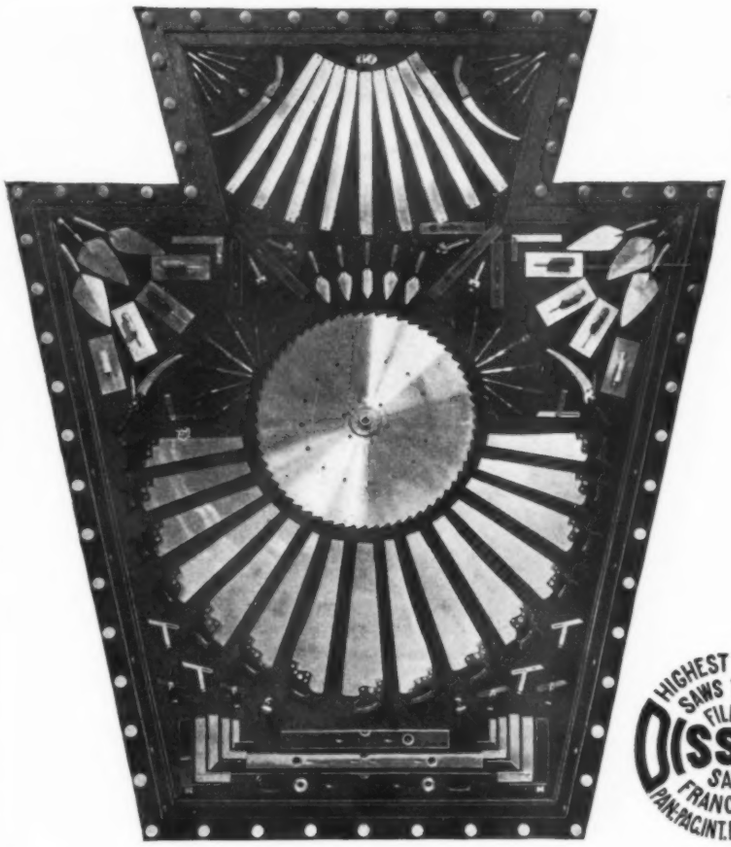
In our constant application to the manufacture of **Universal Hack Saw Blades**, nothing is given consideration except that which will aid in maintaining and improving, if possible, their present high quality.

West Haven Mfg. Co., **New Haven, Conn.**
British Agents—The Fairbanks Co., 115 Mallow Street, Old Street, London, E. C.

HACK "STERLING" SAWS



Diamond Saw & Stamping Works, Buffalo, N. Y.



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Disston Exhibit

Panama-Pacific International Exposition

12 Highest Awards including 4 Grand Prizes

SAWS
TOOLS
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HIGHEST AWARD SAWS TOOLS FILES DISSTON SAN FRANCISCO PAN-PACIFIC EXPOSITION

Henry Disston & Sons
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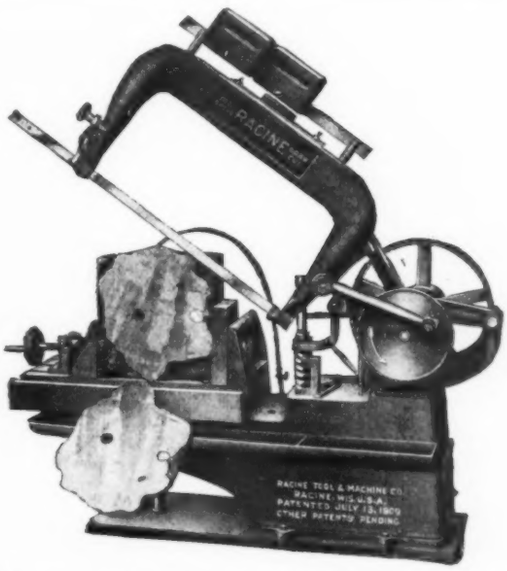
Philadelphia U. S. A.



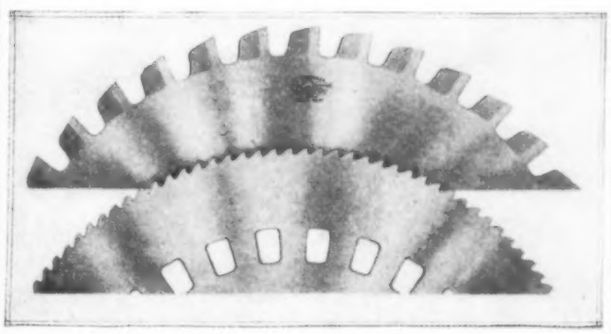
An Unusual Use for an Unusual Machine

Here's a story of how a Racine Metal Cutting Machine was put to a most unusual use. A meteorite fell near Gibeon, German Southwest Africa. It was 15"x15" in size, of nickel iron composition. The owners wished to cut it into ½" slices with the least possible waste. A Racine Metal Cutter was pressed into service and did the whole job in 10 hours—and the maximum variation was only 1/32". Fast cutting—but typical of Racine possibilities.

We will send you a Racine on any trial basis you consider fair. Make it prove its worth in your own plant before you spend more than postage.

RACINE TOOL & MACHINE COMPANY
1400 Jones Ave., Racine, Wisconsin, U. S. A.

Make More Money



You can do it as well as others. The big fellows, using

Atkins Metal Saws

tell us they stand up longer, with least refitting. We'd like the opportunity of showing you anyway. Specify ATKINS. At least—let us tell you about them.

Write for Treatise "A.M."

E. C. ATKINS & CO., Inc.

The Silver Steel Saw People,
Home Office and Factory, Indianapolis, Ind.
Canadian Factory—Hamilton, Ont.
Machine Knife Factory—Lancaster, N. Y.
Branches carrying complete stocks in the following cities. Address E. C. ATKINS & CO.

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AMERICAN BLOWER COMPANY, DETROIT

Sirocco
TRADE MARK.

SHOP HEATING—VENTILATING AND COOLING SYSTEMS

(Patented)

This and a wrench and your workmen are safe

The set screw cannot come in contact with their clothing.
You are, safe, too—from the Employers' Liability laws.

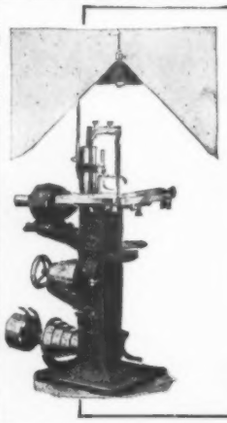
Anti-Accident Crucible Steel Lathe Dogs

have a widening frame that may be carried completely over the top. The set screw does not stick out.

And a simple open end wrench does the job. The dogs come in all sizes and shapes.

We have a size and shape that will fit your needs. Details and prices equally appropriate. Write.

West Steel Casting Company
Cleveland, Ohio



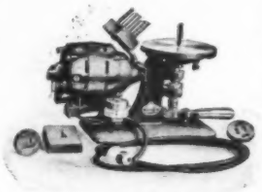
The REARWIN Die Filing Machine

is an improved invention to accomplish more work in less time and with less expensive help than is usually employed at filing dies, this machine has an adjustable stroke from 0" to 7" lower arm is arranged to align cutting edge of standard files, upper arm is adjustable to accommodate files from 3 to 12" in Length.

Both large and small work can be accomplished with this machine as it is so arranged as to run slow or fast without becoming clumsy or out of balance, **for further detail and quotations please write.**

W. D. Rearwin
341 Mill Ave., N. W., Grand Rapids, Mich.

Anderson Die Forming Machine



Built especially for finishing blanking dies and similar work after the core has been drilled out. Equipped with motor that can be attached to ordinary lamp socket. Has a constant cut and does not require change of cutter for every change of contour of surface operated upon. Cutters may be made to taper so as to provide any degree of clearance.

Bulletin No. 1 gives complete details. Write for it.

ANDERSON DIE MACHINE COMPANY
BRIDGEPORT, CONN., U. S. A.

"MILFORD" HACK SAW BLADES

"Go By The Name"

Sample sent on request.

The HENRY G. THOMPSON & SON CO., NEW HAVEN, CONN.

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GERSTNER Tool Cases are correctly proportioned, handsomely finished, light in weight yet very substantial in every detail. They are the standard for superior qualities and never fail to please the most particular mechanic.

J. Gerstner & Sons DAYTON, O. 25-31 Columbia Street Dayton, O

Mfrs. Mechanics' High Grade Tool Cases

BLUEPRINTS
The WICKES

Continuous Electric. Sells at **half the price.** Uses **half** the **current** of others. Perfect prints up to 48" in width and of unlimited length.

WICKES BROS., Saginaw, Mich.

This Ferrule Prevents Splitting

The heavy pressed steel ferrule of the "Doctor" File Handle has an inwardly returned, curved, sharp-edged lip which firmly locks the wooden portion within the enlarged end of ferrule when driven into place.

We have proven the superiority of this handle under hard service. It is manufactured to reduce your file handle costs. A trial will convince you. *Samples free to Firms and Dealers; others send 10 cents in stamps—anyway write today for Free Descriptive Matter.*

DOANE MANUFACTURING CO., Alls Sta., BOSTON, MASS.
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METAL STOOLS and CHAIRS

Any Height. Black, Green or Maroon

3 or 4 Legs

Single or Double Standard Back

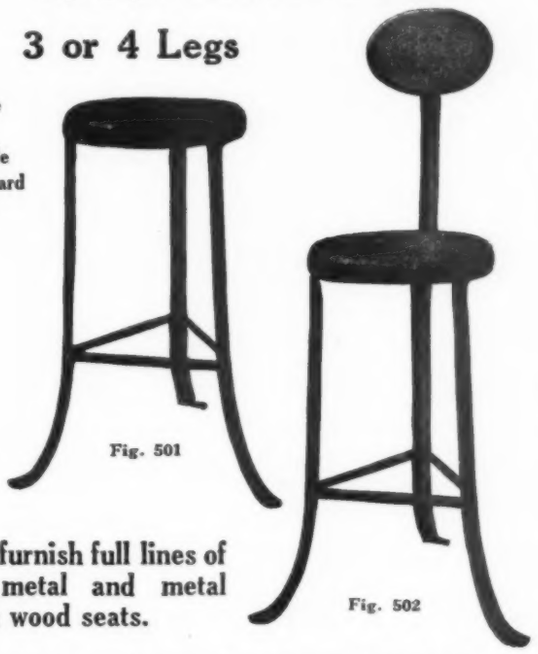


Fig. 501

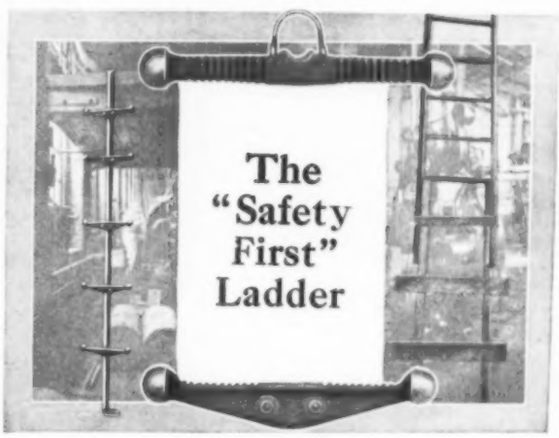
Fig. 502

We furnish full lines of all metal and metal with wood seats.

Send for complete catalog of our metal equipment.

Manufacturing Equipment & Engineering Co.

209 Washington Street, Boston, Mass.



A Shop Necessity

Have you investigated the "New Britain" way—the way that provides a **permanent** ladder for every place in the shop where a ladder is frequently needed?

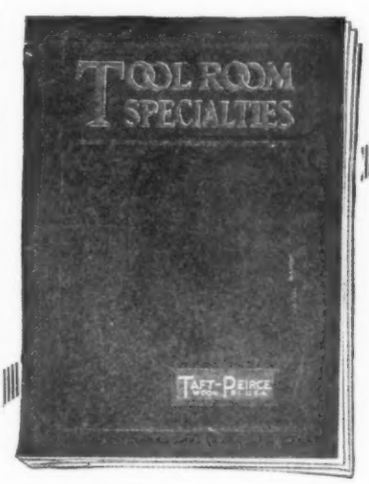
"New Britain" Adjustable Rungs are quickly and easily attached to ordinary 1¼" pipe—and form a strong and indestructible ladder, always on hand just where it's wanted. There's more than one place in your plant where a permanent, strong and trustworthy ladder would save you time and money, and perhaps prevent an accident.

Shall we send you circular?

The New Britain Machine Co.

Shop Furniture Originators

20 Chestnut Street, New Britain, Conn.



Tools that will save you time and money

Our catalog "A" of Tool room Specialties will be mailed free on request. It shows our full line of limit plug and external limit gauges, taper test gauges, bench plates, boring equipments, parrallels, sine bar fixtures, "V" blocks and other tools that will be found economical in tool room and machine shop use. We carry them all in stock.

The Taft-Peirce Manufacturing Co.

Woonsocket, Rhode Island, U.S.A.

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Gilbert and Barker Furnaces

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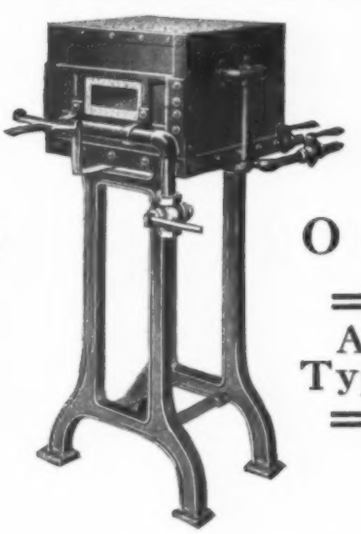
All Sizes



Oil

All Types

Any design and size of furnace that **best** suits your particular conditions for the most efficient heat treatment of metal will be provided by us. Our 50 years' experience in solving metal heat-treating problems is at your disposal. Let's get together now.

Send for Catalog 21. It gives details.

Gilbert & Barker Mfg Co.

11 Union St., Springfield, Mass.

26 Broadway, New York

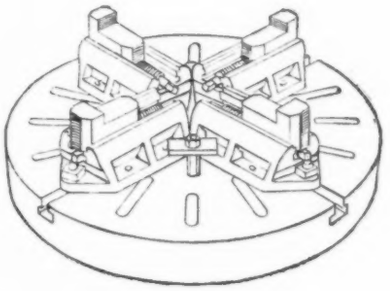
Horton Face Plate Jaws of Improved Design

Horton Face Plate Jaws have been refined in design from time to time until they now approximate perfection for the purpose. They are made with either iron or steel base. The ends are tapered at an angle of 45 degrees so that they may be brought close to the center of a faceplate, in this way taking work of minimum size.

Their base is unusually wide with pockets at the sides to permit the use of straps for clamping.

And the screws themselves have double thrust bearings.

Sizes 4″ to 14″ in iron or steel. Boring mill jaws, too.



New No.12 catalog just off the press awaits your address.

The E. Horton & Son Co.

Windsor Locks, Conn., U. S. A.

THIS IS THE NEW BRITAIN BALL BEARING HAND OPERATED DRILL CHUCK with Morse Taper Arbor as an integral part of the Chuck.

Also furnished with taper hole for separate arbor.

MADE IN FIVE SIZES ranging from 0 to 3/16 capacity to 0 to 1″.

Made of steel throughout, all wearing parts being hardened the ball bearings reduce the friction to a minimum.

New Britain Drill Chucks

SAVE trouble and experiments.

LABOR is saved by the fact that TIME is not lost in looking for the wrench that has become misplaced or broken.

AND this chuck will prolong the life of your drills, as it does not grip harder than is necessary to do the work because it is self-tightening.

EXPENSE and maintenance is to be considered when purchasing drill chucks. The New Britain Ball Bearing Drill Chuck has no gears to become clogged or broken; no wrench to become misplaced.

Let the Chuck Prove It.

Union Manufacturing Co.

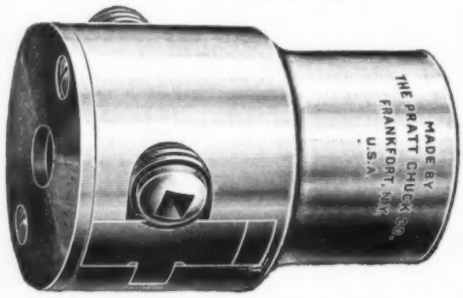
New York Office: 26 Cortlandt St.

New Britain, Conn., U. S. A.

Makers of a Complete Line of Chucks.

The Pratt Chuck

Holds Drills so they can't slip. Our booklet tells why and how



Pratt Chuck Co.,

Frankfort, N.Y., U.S.A.

Sole European Representatives—The Selson Engineering Co., Ltd., 83-85 Queen Victoria St., London, England.

SKINNER DRILL CHUCKS

New Model

The "New Model" is especially adapted to rapid sensitive drilling. It is accurate, light, strong and hand operated.

The price is surprisingly low. Illustrations of complete line on request.

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NEW BRITAIN, CONN.

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A Report On GARVIN Wrenchless Chucks

from a large brass goods plant advises a 50% reduction in cost by the use of these chucks. Is this not worth while investigating at your plant?

Two and Three Jaw Carried in Stock

For Further Information { Ask Your Dealer or Write Us Direct

Full description in Chuck Catalog.

The Garvin Machine Company

Spring and Varick Sts. **50 Years in New York City**

One set of jaws
with this
Geared Scroll Chuck
It's a "Sweetland"

No need of purchasing two sets of jaws with this "Sweetland" Scroll Chuck. *That* expense is saved you.

So is the trouble of an extra set. You can't mislay or break it.

The jaws are made reversible by making the segmental thread sections convex on both their edges.

They can be reversed easily in little time.

Fully described in the Sweetland catalog. Write for a copy.

The Hoggson & Pettis Mfg. Co.
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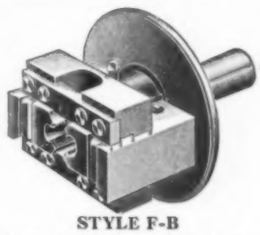
A SOLID DIE WHILE CUTTING, YET OPENS AUTOMATICALLY



STYLE F-B

Adjustable Gib Slide
Assures PARALLEL THREAD
Closer to Shoulder than
Any Other Opening Die

400 half-inch Steel Conduit Connectors **per hour**, cut with **Errington Style "F-B" Rotary Die Head**, after having been adapted for the above work by our Engineering Department. This work has parallel pipe straight thread cut right up to shoulder.

The "Errington" is not only "The Simplest Die That Opens," but the only die that opens and closes while rotating; that can be used on Drill Press, Engine Lathe or Turret Lathe; a Special Tool on **each** job, yet easily adapted to General Work.

Twenty Years' Special Engineering Experience back of each tool to help make a record on your work.

Give us a trial.

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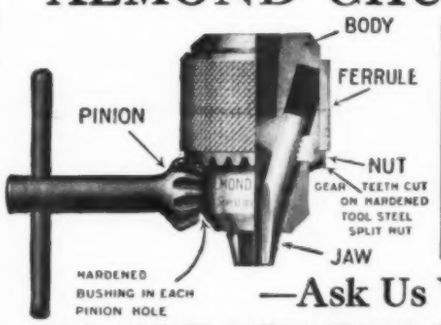
Deutsche Katalog von Arthur Kayser, Berlin S. W., Oranienstr. 126, Agent fur Deutschland und Oesterreich-Ungarn. Catalogue Francais: Edgar Bloxham. Paris, 12 Rue du Delta.

ALMOND CHUCKS



Powerful
Accurate
Durable

Cost Less to Maintain

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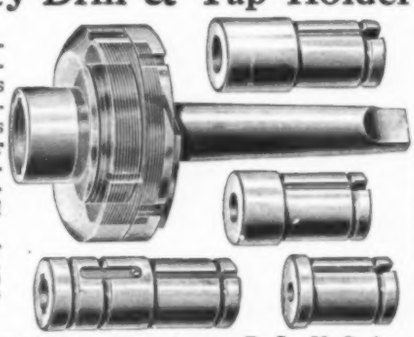
LONDON OFFICE: 8 White Street, Moorfields, London, E. C.

The Safety Drill & Tap Holder

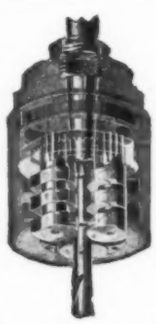
is the only attachment for the purpose that gives universal satisfaction and is **Unequaled for Efficiency, Convenience, Rapidity, Accuracy and Simplicity.**

Nothing to *break* or get out of *order*. Made in 4 sizes covering from 0 to 2½ in. diameter.



The Beaman & Smith Co., Providence, R. I., U. S. A.

Builders of Boring and Milling Machines, and Special Machines for such Purposes Constructed.



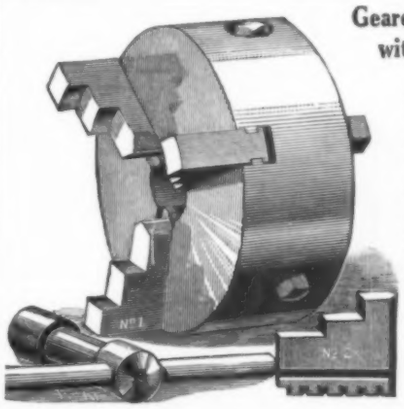
"QUICTITE"
Full Automatic Chuck

You don't have to stop the drill press to shift drills if you're using a "Quictite." Even straight-shank drills are locked with a sure grip while the press is in motion. The secret lies in the nine-fold grip, which holds the drill firmly but never cuts the shank.

No keys—no collets—no exposed teeth or points.

We'll be glad to tell you more about the "Quictite" and about our 30-day free trial offer.

Automatic Drill Chuck Corp'n
Detroit, Mich.



Geared Scroll Chuck with a Solid Body

Whiton's Geared Scroll Chucks are made in one solid piece without any joints. There are no other geared scroll chucks made like it and no other that will give such absolute satisfaction. Catalogue describes it and the many other Whiton superior chucks.

D. E. Whiton Machine Company
New London, Conn.

Sole European Agents—Selson Eng'g Co., Ltd. "Whiton" Chucks sold and kept in stock by principal dealers all over Europe.

A Wahlstrom Automatic for Straight Shank Tools

Think of being able to make tool changes in 2 seconds—and without stopping the spindle of the drill press. Just grasp the shell of the chuck with one hand and with the other, take out or insert the desired tool.

You will know what chucking efficiency means when you install

Wahlstrom Automatic Chucks

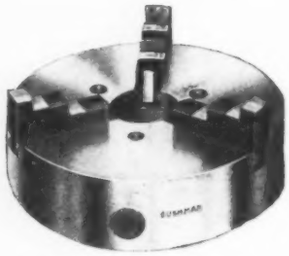
Positive drive, self centering *Automatic* Drill Chucks which may be set up to drill, ream, counterbore, and tap without lost time in stopping and starting drill press spindle.

Try the chuck out thoroughly on those drilling, reaming or tapping jobs that have been costing too much. If it won't save money return it at our expense. Fair enough? **Where shall we send yours? There's a Wahlstrom Automatic Chuck for M. T. Shank Tools too.**

Shall we tell you what it will do towards making your drilling more profitable?

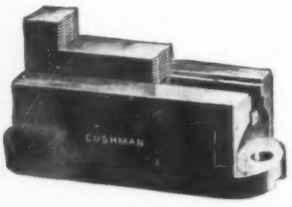
The Wahlstrom Tool Company

350 Carroll St., Brooklyn, N. Y.



"Blue Line" Universal Scroll Chucks—3-Jaw and 4-Jaw.

All Steel



"Blue Line" Portable Face Plate Jaws.

All Steel

And Now We Have the "Blue Line" Models

"The world do move" as the old darky said and you've got to keep the pace or take somebody's dust.

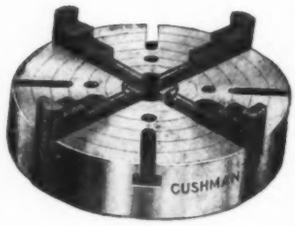
The increasing use of special and extra heavy machinery, the use of high speed steel for cutters and tools, and the constant call for higher speeds and greater production put more of a load on chucks and face-plate jaws than they were made to carry.

Chucks were needed that would stand up under heavier cuts and higher speeds than ever before—and so we made them.

We call them the "Blue Line" Chucks. They're all-steel, specially treated, and guaranteed to meet all demands of modern machinery. In all other ways they are typical Cushman Products. Need any more be said?

The Cushman Chuck Co.

Hartford, Conn.



"Blue Line" Independent 4-Jaw Chucks.

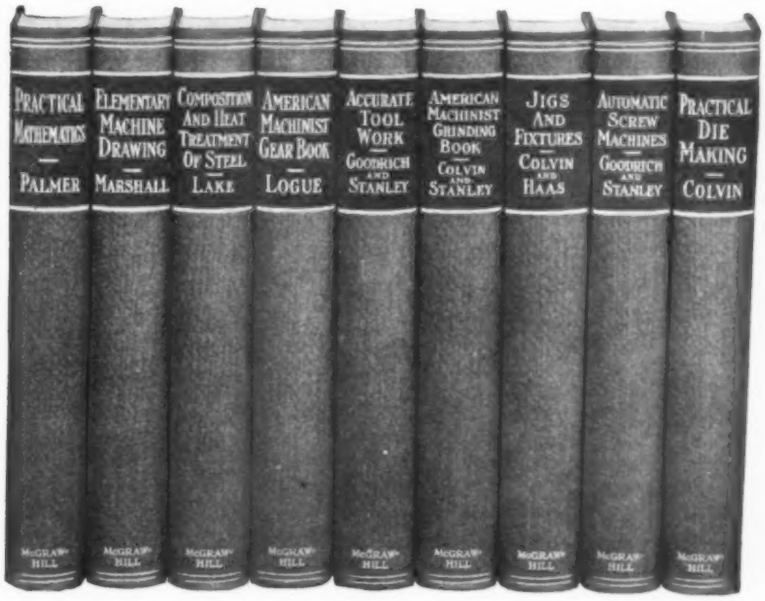
All Steel

"Blue Line" Drill Chucks.

All Steel

"The Best I Have Ever Seen"

That is the Consensus of Opinion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equipped with a full quota of modern tools and manned by a superb organization of trained workmen are at your service for building

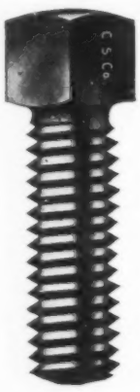
Special Machinery

from your blueprints and specifications.

Let us develop and manufacture your product on a contract basis at an attractive figure.

Forty years' experience in building dies, jigs, fixtures, tools and special machinery. **Why not let us estimate on your work? Send blue print today.**

C. H. COWDREY MACHINE WORKS
Fitchburg, Mass.



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Promptness and accuracy guaranteed. Prices reasonable. Correspondence solicited.

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Specialists in Building Special Tools and Machinery

We have the men—the machines—the experience and knowledge to make a success of whatever we undertake to handle. High grade equipment means high grade product. **Write for Descriptive Booklet.**

TOOLS—JIGS—FIXTURES

We make jigs and fixtures and special Tools at reasonable prices with uptodate Equipment.

THE STANLEY CO., 48 Loring Ave., SALEM, MASS.

Machines and Parts

We can handle your contract machines or parts. We also make stampings and metal novelties to order. Get estimates.

ENSIGN MFG. CO.,
Faneuil Dist. Boston, Mass.

Tools, Jigs, Fixtures and Dies We Make Them

We are especialty equipped to produce the above. Bench lathes and automatic gear cutters are in our line. Ask for Bulletins Nos. 1 and 2.

Sloan & Chace Mfg. Co., Newark, N. J.

SPECIAL TOOLS

We make dies, jigs and fixtures. Our work is of the highest quality and our prices are very reasonable. We employ highly skilled die-makers and our equipment and shop conditions are practically perfect.

A trial will prove this.

NELSON TOOL CO, Inc.
781-783 East 142d Street **New York City**

Contract Work

Undecided About That New Equipment?

We can advise you.

If you are starting into a new and unfamiliar field we can help you in planning operations and suggesting equipment.

We are Practical Manufacturing Engineers—a firm composed of men with twenty years of real experience in the reduction of manufacturing costs. **Write us fully about your problems. Our engineers will analyze them and submit you a proposition.**

The H. E. Harris Engineering Company
Bridgeport, Conn.

Wanted:—

Several good live concerns who need

Special Machines *Dies, Jigs, Tools*
Automatic Machines *Fixtures, etc.*

and know and appreciate good workmanship. Our shop is adequately equipped to handle the largest jobs and work is turned out *on time.* Let us give you an estimate on your next outside work. Send us the blueprints.

American Machine & Foundry Co.
200 Fifth Ave. New York
352 Carroll St. Brooklyn

H.B.UNDERWOOD & CO. EST.1870

We maintain an emergency repair service which enables us to start the right men with the right tools to any **engine repair job** almost as soon as your message is received.

Try us and see. You can't catch us unprepared.

PHILADELPHIA, PA.

G.P.&F. Service
Knowing How Since 81

SPECIAL STAMPINGS

More than thirty-four years' experience in drawing, spinning and stamping metals and a plant covering more than fifteen acres of floor space enables us to do difficult work right. Send blue prints or samples for estimates.

GEUDER, PAESCHKE & FREY CO., 1301-1700 St. Paul Ave., MILWAUKEE, U. S. A.

Do You Use Springs

If you use springs you should use "Barnes-made" Springs. They are different from so-called "Commercial" springs and their action may be depended upon.

We make all styles, in all sizes and from all spring materials.

And our latest booklet is just what you should look over before you order springs.

(Kindly ask for "Booklet 6-A."

Established 1857
THE WALLACE BARNES COMPANY
38 Wallace Street Bristol, Conn., U.S.A.

Man'frs of "Barnes-made" Products
Springs, Screw Machine Products, Cold Rolled Steel and Wire

Sheet Metal Stampings

Light Drawn and Flat Work
Washers, Cable and Pipe Clips.
Literature on request.

The Kales-Haskel Co., Detroit, Mich.

Dies, Jigs, Tools, Fixtures

Years of experience in the making of tools, jigs and fixtures are your assurance of accurate, high quality work. State your requirements and let us quote you.

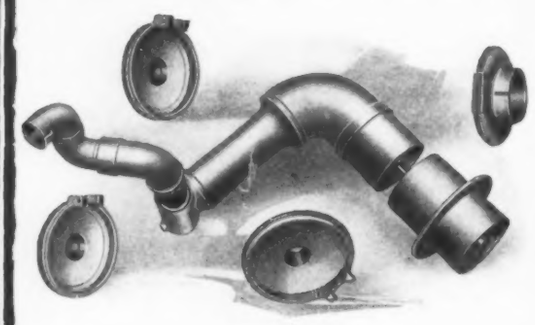
The Modern Tool, Die and Machine Co.
Columbus, O.

DESIGNERS

of Special Tools and Machinery for Manufacturing Interchangeable Parts

Mulliner-Enlund Co., Inc., Syracuse, N. Y.

Parts Doehler Die-Cast Mean a Faster and More Economical Production



Doehler Die-Casting of parts cuts production costs to the minimum.

The manufacturer uses no power or light except for assembling—he suffers no loss in machining defective castings—he has no money tied up in machinery, jigs and tools—his financial investment is confined to a few dies—maintained by us without charge and in first-class condition—and, generally speaking, we produce the castings very much faster than he can use them.

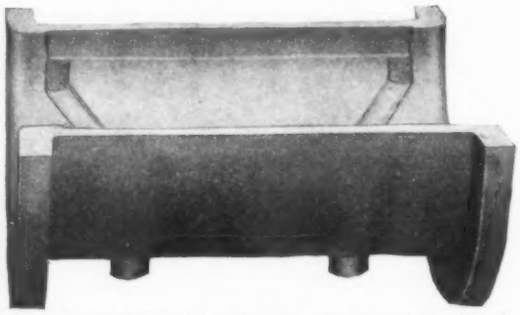
DOEHLER DIE-CASTINGS

have all threads, holes, slots, notches, recesses, etc., accurately located. The finish is smooth and beautiful and well adapted to buffing, polishing, plating or enameling.

Send us your blue prints and models of parts and let us tell you what the actual cost will be to have them Doehler Die-Cast. It has often been found that a machine part pronounced a casting impossibility can be made a possibility through the ingenuity of our designers. Consult us; our advice is worth having.

DOEHLER DIE-CASTING CO.
BROOKLYN, N.Y.
TOLEDO, OHIO.

Producers of Die Castings in Aluminum, Zinc, Tin and Lead Alloys. Also Manufacturers of Die-Cast Babbitt Bearings and Babbitt-Lined Bronze Bearings



This high-grade Babbitt bearing is made strong, accurate and durable by our automatic die-casting process.

WHY spend money unnecessarily for machining parts that could be die-cast accurately and rapidly at a saving?

May we estimate on your needs?

LIGHT MFG. & FOUNDRY CO.
Pottstown, Pa., U. S. A.

59

Castings

Engine Bases
Cylinders
Fly Wheels
Turbines
Anything—

Large massive castings weighing up to 150,000 lbs. each are our specialty. We'll handle any job you put up to us in molding iron or semi steel of the highest quality and greatest strength. Let us quote you—our experience is at your service.

Foundry Department
Farrel Foundry & Machine Co., Ansonia Connecticut

WOULD YOU SPEND TWO CENTS

if you thought you could save a hundred dollars? Die-casting may be the means of saving you more than that. Two cents spent for postage is all it costs to find out. *Write for our booklet, "Die Castings."*

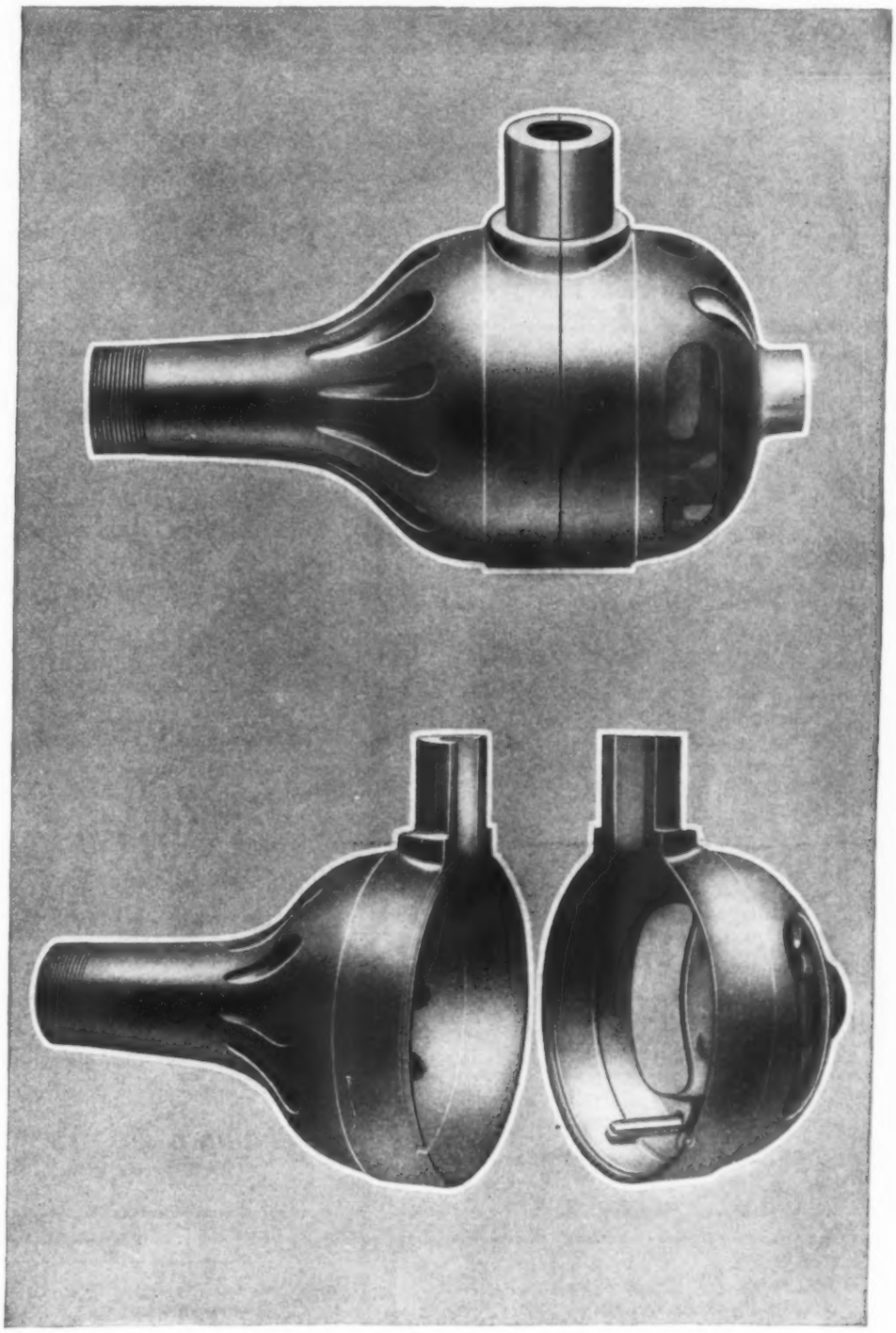
NATIONAL LEAD COMPANY
111 Broadway Room 1924 New York, N. Y.

ACME Die Castings

You will find our die-castings uniformly accurate, close grained and of beautiful finish. Considering the quality the cost is exceedingly low.

ACME DIE-CASTING CORPORATION
Bush Terminal No. 5, 35th Street and 3rd Avenue
BROOKLYN, N. Y.

Stewart



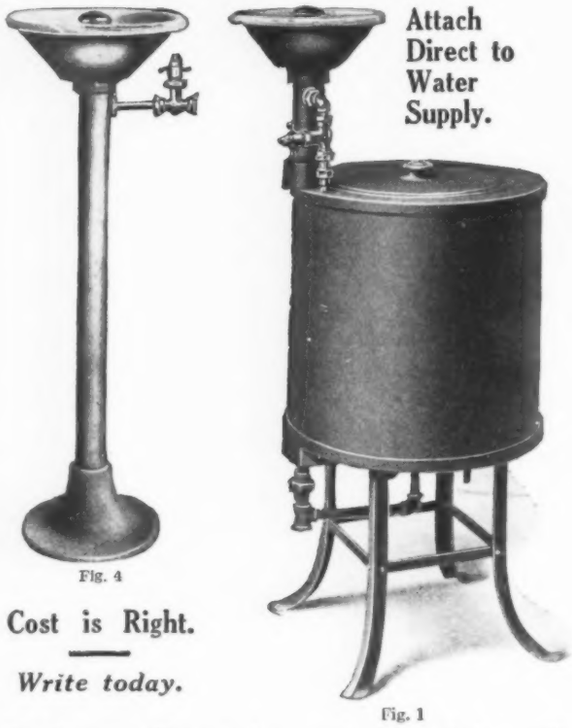
Two things we do—we are the world's largest makers of diecastings—and we are the makers of the Stewart steel reinforced bearing—both big improvements over old methods—and both cost cutters. Send for booklets—today. The Stewart Manufacturing Company, Wells Street Bridge, Chicago, U. S. A.

"W & B" DROP FORGINGS

¶ We make a specialty of the highest grade Drop Forgings. Our exceptional capacity and equipment insure accurate forgings and prompt delivery. Send us models and blue prints and permit us to estimate on your requirements.

The
Whitman & Barnes Manufacturing Co.
Established 1854
120th Street CHICAGO, ILL.

BUBBLING FOUNTAINS
ICE COOLED OR PLAIN



Attach Direct to Water Supply.

Fig. 4

Fig. 1

Cost is Right.

Write today.

Sanitary Fountain and Specialty Co.
176 Federal St. Boston, Mass.

Castings for all purposes
Rough cast BUSHINGS in stock

THE PHOSPHOR BRONZE SMELTING CO.
ELEPHANT BRAND
2200 WASHINGTON AVE., PHILA., PA.
ELEPHANT BRAND *Phosphor Bronze*
INGOTS, CASTINGS, RODS, SHEETS, WIRE, ETC., ETC.
— DELTA METAL —
IN BARS FOR FORGING AND FINISHED RODS
DELTA REG. U. S. PAT. OFF.
ORIGINAL AND SOLE MAKERS IN THE UNITED STATES

Near Size Finished drawn **TUBING for BEARINGS**

GERMANN DIE-CAST PARTS
finished complete to blueprints in
ALUMINUM
and
ALUMINUM ALLOYS
also in Tin, Zinc, Lead and Babbitt Compositions.
Send blueprints or samples for estimate.

Germann Bronze Co., 345 West 19th St. ERIE, PA.
Descriptive booklet on request.

DIE CASTINGS
Our new factory with every equipment for the manufacture of "Quality Die Castings" is at your service. We solicit an opportunity to quote on your requirements.

American Die Casting Co., 39-41 So. 6th Street, Newark, N. J.

Our Specialty Is
MACHINERY for MAKING WOOD SCREWS
ASA S. COOK COMPANY, HARTFORD, CONN., U. S. A.

Established 1902
MOBERG DIE CASTINGS
We do not claim to be the only die casting concern in the country, but have customers who say we are.

C. J. Moberg, Inc. Mount Vernon, N. Y.

Enlarge Your Working Capacity the "Davenport" Way
The wide range of screw machine jobs and the large output made possible on the Davenport Multiple Spindle Automatic Screw Machine, enlarges the working capacity of any shop having this kind of work to do.

There's no sacrifice in accuracy or finish to get the "Davenport" output.

Many users say that they have taken on business which could never be touched under old production costs.

Let us send you our Catalog. Now?

Davenport Machine Tool Co., New Bedford, Mass.

SOUTHWARK

Piercing and Drawing Presses

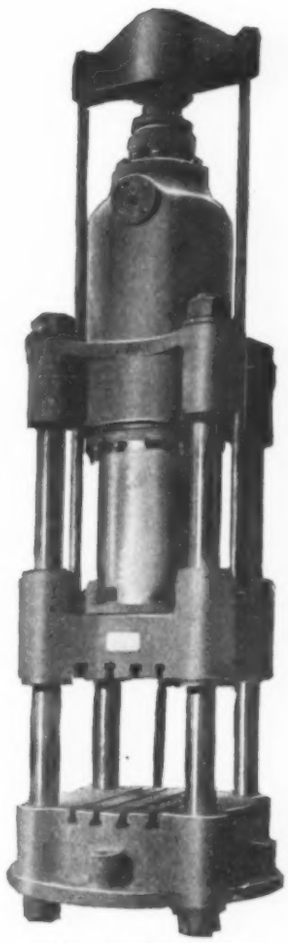
The Southwark 350-ton Shell Piercing Press is suitable for all of the piercing operations connected with the manufacture of steel shells.

This type press is the result of extensive experience in building hydraulic equipment.

The speed and pressure are absolutely correct and although built with the idea of obtaining the greatest strength, the press is easily operated and readily controlled.

There are other Southwark designs for nosing and band-shrinking operations.

If in need of hydraulic equipment for any purpose consult us.



350-Ton Shell Piercing Press

The services of our corps of expert engineers are at the disposal of manufacturers desiring press equipment for the production of steel shells. Write for a copy of our Bulletin.

SOUTHWARK FOUNDRY & MACHINE CO.

Old Colony Bldg., Chicago — Home Office and Works: Philadelphia — Brown-Marx Bldg., Birmingham

Drop Forgings——

(PS)

The Story of the Tailor and Apollo Belvidere

A tailor went to an art museum where they have a statue of the Greek god, Apollo Belvidere.

The tailor was so impressed with the statue's beauty that he decided he would do him honor by measuring all men by the god's standards.

The result was some curious misfits and the tailor lost all his trade.

(PS) Drop Forgings, made to order, are never "misfits" because they are made especially to fit customer's individual requirements.

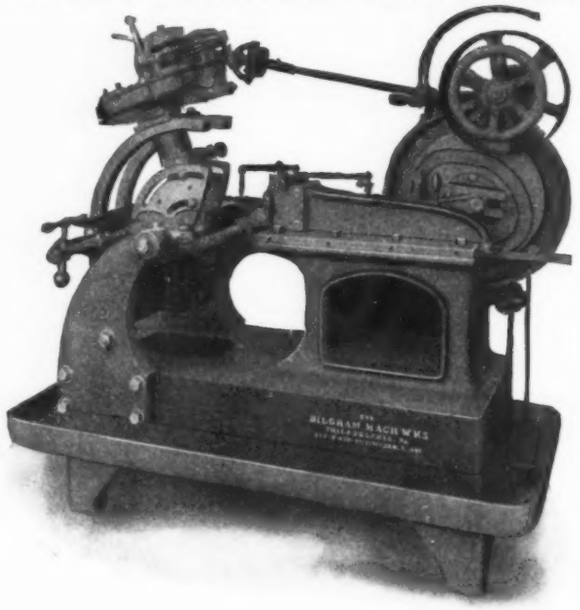
At the same time we hold them up to the highest standard of quality.

The result of this combination is that we have been able to please some manufacturers with drop forgings who have never been satisfied before.

From the material used to the finish required (PS) Drop Forgings suit your requirements.

Page-Storms Drop Forge Company
Chicopee **Massachusetts**

BEVEL GEAR GENERATORS



Bevel Gears

are cut by us theoretically correct, and so are adapted to fine machinery of all kinds. We have special facilties for cutting SPUR, WORM, SPIRAL, MITRE, INTERNAL and ELLIPTICAL Gear Wheels. Let us quote on your specifications.

The Bilgram Machine Works 1233 Spring Garden St. Philadelphia, Pa.

There's No Dangerous Slip

An absolutely tight grip is secured on every nut if you use the genuine

"COES" WRENCH

Fully 30 per cent. **stronger** than other wrenches. Backed by 74 years' experience in high grade wrench making.

The ideal wrench for service in the modern machine shop. Made in many sizes from 6 inches to 6 feet long. **Write for your copy of the "Coes" Wrench Book.**

Coes Wrench Co., Worcester, Mass.

AGENTS—J. C. McCarty & Co., 29 Murray St., New York. John H. Graham & Co., 113 Chambers St., New York, or your dealer.

For the Painting of Shells

The "Spraco" Painting Machine coats either the inside or the outside, or both of the shell in a few seconds—completely and without air bubbles or bare spots. The paint film can be regulated to any desired thickness.

Write for Bulletin No. 210.

SPRAY ENGINEERING CO., 91 Federal St., Boston, Mass.

Inspectors Furnished

Will represent you at places where you are having materials manufactured.

You can be sure that everything is correct in quality, uniformity, dimensions and weight.

All our inspectors are experienced engineers. The inspection of export shipments is solicited. Write us about your requirements.

Henry Souther Engineering Corp., Hartford, Conn.

Ready for Any Emergency

ALL TOOLS SHIPPED ON TRIAL FREE

The Great **Thor** *Factory*

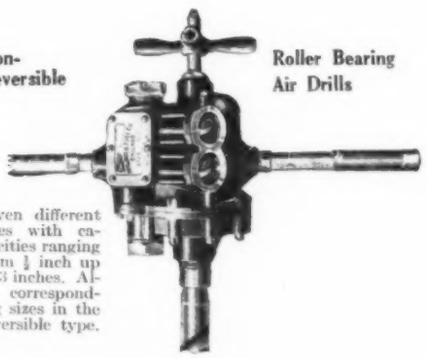
ASK FOR CIRCULAR W SHOWING ENTIRE LINE

The Largest Plant of its Kind in the World

Our plant at Aurora, Illinois, is the largest factory in the world—Devoted exclusively to pneumatic and electric tools. No order too big or too small.

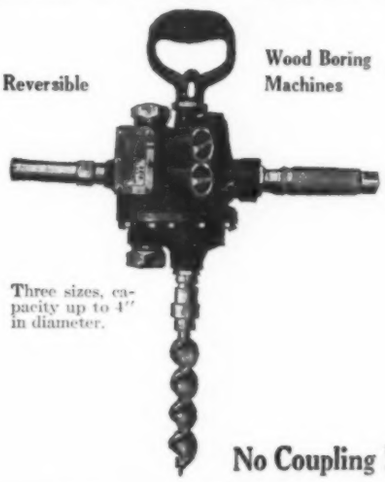
JUST A FEW OF THE TOOLS MANUFACTURED

Non-Reversible Roller Bearing Air Drills



Seven different sizes with capacities ranging from ¼ inch up to 3 inches. Also corresponding sizes in the reversible type.

Reversible Wood Boring Machines



Three sizes, capacity up to 4" in diameter.

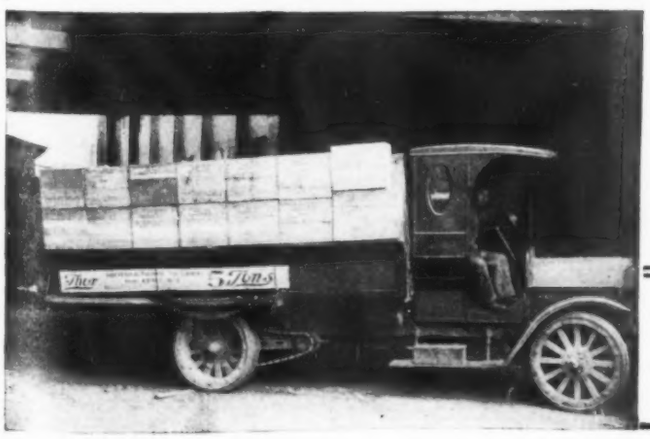
Electric Drills

Seven sizes, capacity up to 1¼ inches.

No Coupling Here ↓

Long stroke, riveting, hammers, four sizes, for driving rivets up to 1¼ inches.

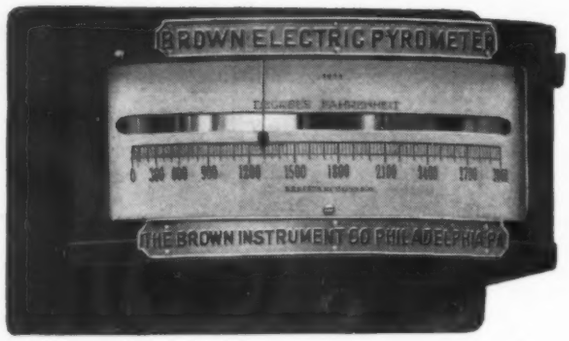
A Record-Breaking Shipment



Five tons of Thor Pneumatic Tools for one customer.

Independent Pneumatic Tool Co.

Chicago New York Pittsburgh Detroit
San Francisco Atlanta Montreal



Do You Want Better Pyrometers?

Why Brown High Resistance Pyrometers have all the good features of low resistance Pyrometers and none of the bad ones.

Just suppose you are measuring a temperature of 1400 deg. F. with a low resistance Pyrometer of 5 ohms resistance, using a 36" thermo-couple and 50 ft. of two-conductor wire. The thermo-couple burns away, and you have to shorten it to only two feet long. Your low resistance Pyrometer will show 20 deg. too high.

Suppose your wire is too short and you have to lengthen it to 100 ft., your Pyrometer will read 40 deg. low. Or suppose the room temperature along the wire increases from 50 to 100 deg. from winter to summer, your pyrometer would show 18 deg. low.

This isn't true of Brown High Resistance Pyrometers with a resistance of 150 ohms. Figure the ratio of 5 ohms to 150 ohms, or 1/30th, and estimate 1/30th of the above errors. It's less than a degree. Now you realize why high resistance Pyrometers are so rapidly replacing the low resistance ones.

And the best of it is, they cost little more than the low resistance kind.

These improved Pyrometers are described in our 64-page catalog No. 7.

The Brown Instrument Company, Philadelphia, Pa.
New York Pittsburgh Chicago

Wanted Immediately

By an Ohio Manufacturer

(*New or Second-Hand*)

Pratt & Whitney 12-spindle multiple drills or similar machines.

Gear hobbers, either Schuchardt & Schutte No. 0 and No. 00 or Adams-Farwell No. 1.

Also hand screw machines.

Give full particulars as to condition, price and delivery.

W 909—American Machinist
1144 Monadnock Block, Chicago

Have you idle machinery to dispose of?

Machines in good condition replaced by others of larger capacity, or better adapted to your work. Machines that represent idle capital and valuable floor space *wasted*. Machines that would *just suit* some other reader of American Machinist—

A "For Sale" advertisement in these pages costs little and will list your machines to 21,900 *subscribers.*

Fully-Equipped Machine Tool Plant

FOR SALE

Suitable for manufacture lathes, presses, shapers, etc.

Located in Ohio.

R.R. Siding — connecting with two first-class railroads. Good foundry. Machine shop equipment modern in every respect.

For further particulars see

Geo. E. Neil, Mgr.
Machine Tool Dept.

Fairbanks-Morse & Co.
30 Church Street, New York City

For Sale

Factory of modern construction, practically new, covering about 18,000 sq. ft. Situated on railroad with spur-track. Adapted to the manufacture of forgings or foundry work. Located in small community, no saloons and good labor conditions. 10 Miles from the city of Hartford. An exceptional opportunity.

For particulars apply to

The Billings & Spencer Co.
Hartford, Conn.

FOR SALE

Iron Foundry, Dimensions 28,000 Square Feet, and **Pattern Shop,** Dimensions 9,000 Square Feet, located on good trackage adjacent to center of City of Denver, equipped with traveling cranes, etc. For sale at bargain price. Address FS 802, American Machinist.

ONLY RELIABLE PRODUCTS CAN BE CONTINUOUSLY ADVERTISED

Nicholson Expanding Mandrel

How *Fast* Can You *Center* This Job?

Two Nicholson Mandrels — one dropped in each end — center themselves instantly in a job like this, no matter whether the two ends of the hole be the same or different diameters.

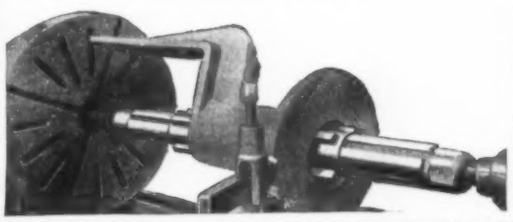
This automatic centering, this instant fit in any hole within the range of the tool — are exclusive features of this **high speed** expanding mandrel.

The small illustrations show the simplicity of its construction.

We will gladly loan you a Nicholson Expanding Mandrel that will take any particular size bore you desire between $\frac{3}{4}''$ and $7''$, to test thoroughly for 30 days.

Better write now, while this is fresh in your mind.

W. H. Nicholson & Co.
114 Oregon Street
Wilkes-Barre, Penna.



For Sale Second Hand Machinery

Rates: Less than 4 insertions 60 cents per line—4 to 11 insertions 55 cents per line—12 or more insertions 50 cents per line. Equipment Wanted items appear at the end of this list.

ADVERTISERS' NAMES are abbreviated in most of these items. Complete names and addresses follow:

AMERICAN Machinery Exchange, 251 Centre St., N. Y. C.
C. & F. CO.—Chandler & Farquhar Co., 419 Atlantic Ave., Boston, Mass.
CINCINNATI Auto. Machine Co., Oakley, Cincinnati, Ohio.
CURRIER & Sons, Cyrus, 365 Market St., Newark, N. J.
MACHINERY Merchants, Inc., 50 Church St., New York.
MARSHALL & Huschart Machinery Co., Chicago, Indianapolis, St. Louis.
MODERN Mchry. & Eng'r'g Co., Ford Bldg., Detroit, Mich.
NEW YORK Machinery Exchange, 50 Church St., New York.
SEYFERT'S Sons, Inc., L. F., 437 N. 3rd St., Phila., Pa.
SOUTH SIDE Fdry. & Mche. Works, Charleston, W. Va.

BOLT CUTTERS

2" National; 1½" Detrick & Harvey; 2" Merriman.—NEW YORK.

BOLT MACHINES

1" and 1½" Acme, 2 head bolt threaders.—MACHINERY.

BORING MACHINES

Nicholson & Watermann horizontal.—CURRIER.

BORING MILLS

1—72" Niles two heads.—SEYFERT'S.

30" Bullard; 6" Barrett horizontal.—MARSHALL.

DRILLING MACHINES

Two 4-spindle Leland ball bearing; 28" Blaisdell, sliding head, upright.—C. & F. CO.

36" Cincinnati upright sliding head, back geared, power feed drill.—CURRIER.

Foote-Burt heavy duty 2 spindle; No. 25 Foote-Burt high duty; 32" Quint 6-spindle multiple turret; Bausch 8-spindle multiple; 2 Baker Bros. style "M", 2 style "F".—NEW YORK.

[Radial]

3' and 4' Prentice radial; 4' Niles Universal radial; 6' Bickford plain.—NEW YORK.

36" Gang plain radial; 6' Universal full Universal radial.—MARSHALL.

1—5' used radial at half price.—SOUTH SIDE.

ENGINES, GAS

Westinghouse vertical, 40 hp., now running; in best possible condition. Selling because of purchase of a larger unit. Delivery about Feb. 1.—The Acklin Stamping Co., Toledo, O.

FORGING MACHINERY

1 No. 1 Ajax taper forging roll machine, having capacity for tapering lengths 19 to 20", and width of roll dies is 20". This machine has capacity for working up from 1¾" to 2" stock.—HOUK MFG. CO., Buffalo, N. Y.

GEAR CUTTERS

2 Whiton cutters.—MODERN.

48" Brainerd; 60" Gould & Eberhardt; No. 6 and 24" Fellows gear shapers; 12" Gould & Eberhardt gear hobber.—C. & F. CO.

15" Gleason bevel gear planer; 36" Cincinnati gear cutter.—MARSHALL.

GRINDERS

4 Warner & Swasey double head Internal grinding machines.—MODERN.

3 No. 1½ Landis internal, good as new.—MODERN.

Besley disk grinder.—MARSHALL.

HAMMERS

25- and 60-lb. Bradley-Helve; 1,500-lb. Morgan steam; 800-lb. Bement steam; 100-lb. Hackney power.—NEW YORK.

KEYSEATERS

1 No. OO Baker, $185.—CINCINNATI.

LATHES

15"x6' Blaisdell; 16"x6' Flather, C. R., T. A.; 16"x6' Lodge & Shipley, quick change, C. R., T. A.; 16"x6' Pratt & Whitney, C. R. and T. A.; 17"x8' Blaisdell; 30"x12' Bradford; 30"x16' Fifield.—C. & F. CO.

2—18"x6' Porter engine lathes, good condition.—MODERN.

90"x10' triple geared used lathe, good condition, at bargain.—SOUTH SIDE.

36"x18' bed F. S. Perkins engine lathe.—CURRIER.

Stevens 26" pulley lathe, comp. rest, oval attachment, latest model.—Newark Second Hand Machinery Co., 105 Chestnut St., Newark, N. J.

All sizes from 14" to 50", cone head machines; geared head machines; quick change lathes.—NEW YORK.

12", 13", 15", 16", 18" South Bend (New); 14" Miami; 14" Bradford; 16" G. M. (New); 24" New Haven; 26" Bradford.—SEYFERT'S.

Rivett bench lathe, comp. slide rest; 16x6 Flather lathe, comp. slide rest; 17"x8' Fitchburg, comp. slide rest; 18x10 Rahn, Mayer & Carpenter, comp. rest; 24x16 New Haven; 26x14 Bridgeford, with taper; 36x12 Putnam; 36x12 Niles.—MARSHALL.

MILLING MACHINES

No. 1 Cincinnati Universal; No. 1½ Cincinnati Universal; No. 3 LeBlond Universal; two No. 2 Cincinnati plain; No. 4½ Garvin plain; two No. 13 Garvin plain; No. 2 Newton Keyseat Milling Machine; No. 1 Brainerd plain; No. 3 Garvin; No. 2 Fox plain.—New York.

No. 24 Brown & Sharpe plain; No. 2 Beaman & Smith slab miller, table 24x8.—MARSHALL.

1 No. 3 Lees-Bradner thread milling machine, new, never been used. Chuck ground for 3" Russian shrapnel.—CONSOLIDATED CAR HEATING CO., Albany, N. Y.

PIPE MACHINES

4" Saunders threader; 4" nipple cutter.—MACHINERY.

12" Saunders; 8" Saunders; 2" Jarecke.—NEW YORK.

PLANERS

30"x30"x8' Pond; 32"x32"x10' Fitchburg; 36"x36"x10' Pond; 48"x48"x20' Putnam.—C. & F. CO.

PRESSES

2 No. 29 Bliss double action automatic sheet feed presses in first-class condition, not having been in use more than 3 mos.; absolutely no marks of wear thereon. Cost $6,500 each. A bargain for someone having use for same.—THE ROCHESTER PNEUMATIC CROWN SEAL CO., Rochester, N. Y.

2 No. 19 Truesdale stamping presses, good as new; price $125 each. Address ELMER W. DAY, Rochester, N. Y.

PUNCHES AND SHEARS

1 Badger "G," 8" throat.—MODERN.

SAWS

1 Chas. E. Wright 36" metal bank saw.—CURRIER.

SCREW MACHINES

1" Garvin screw machine.—MARSHALL.

[Automatic]

6—2½" Cleveland plain full universal.—AMERICAN.

6—⅝" Cincinnati, $800 each.—CINCINNATI.

¼" Hartford bench type; ⅝" Cleveland.—MARSHALL.

SEPARATORS, OIL

1 No. 2, manufactured by American Tool & Machine Co., new value $220, our price $175.—FITZGERALD MFG. CO., Sta. A, Winsted, Conn.

SHAPERS

15" and 24" Hendey, power down feed to head.—C. & F. CO.

16" Cincinnati; 18" Barker & Chard crank shaper; 20" Cincinnati crank shaper.—MARSHALL.

SHEARING PRESS

1 New Doty, 24" throat.—MODERN.

TUBING, COPPER

On hand for quick sale about 7,500 ft. 2 inches outside diameter ⅜ thick in lengths of 54 inches. Price below market. FS 860—Amer. Mach.

TURRET LATHES

Five 8½"x16" Potter & Johnston automatic.—C. & F. CO.

Two 3"x36" Jones & Lamson 2 spindle machines; five 2"x24" Jones & Lamson, cone head; one 41" Gisholt Turret, two 21" Gisholt Turrets. Other makes and sizes of Turret Lathes.—NEW YORK.

21" and 22" Gisholt; 2x24 Jones & Lamson, cone head.—MARSHALL.

WANTED

Shaper—Used double head Traverse, not less than 26" stroke nor less than 14' long.—Bertsch & Co., Cambridge City, Ind.

Additional advertisements of second hand machinery for sale on pages 158, 159 and 161

WE have a constant supply of used machine tools on hand. Let us help you meet your requirements.

Prentiss Tool & Supply Co.
Singer Building
New York

The "Hilclark" Way

Condition:—

Every one of our second hand machines are thoroughly overhauled by skilled mechanics; cleaned, painted and made as near new as possible.

Guarantee:—

Return the machine within thirty days from shipment, freight prepaid and your purchase price will be refunded.

YOU TAKE NO CHANCES

When You Buy of

Hill, Clarke & Co., Inc.

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156 Oliver St.

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136 Cedar St.

Impossible to List

Owing to the great demand and constant changing of stock, it is impossible to satisfactorily list our line of tools but we always have on hand, a large and well assorted stock of Machine Tools, to select from.

Consult us before purchasing.

FRANK TOOMEY, Inc.
127-129-131 N. Third St., Philadelphia, Pa.

SECOND HAND TOOLS

2—1x6 Pratt & Whitney Screw Machines.
2—1½x6 Gray Screw Machines.
2—12x4 American Turret Lathes.
2—13x4 Dreses Turret Lathes.
1—14x6 Star Lathe.
3—15x5 Dreses Turret Lathes.
1—15x6 Barker Turret Lathe.
1—36x26x8 Putnam Planer.
1—30x30x10 Gleason Planer. Lathe.
1—48" x 48" x 14' Fitchburg, Planer, 1 hd.
1—36x36x8 Pratt & Whitney Planer.
1—Niles Floor Planer Head.
1—24" Hendey Shaper.
1—26" Kerkhoff Upright Drill.
1—Grindstone and Frame.
6—⅝ Cinti. Aut. Screw Machines.
1—No. 00 Baker Keyseater.

The Cincinnati Planer Company
Cincinnati, Ohio

FOR SALE

1—18x10 LeBlond Lathe, good as new.
1—16x8 LeBlond, with power turret on bed, new.
1—60x10 New Haven chucking Lathe, C.R., P.C.F., 5 step cone, 4½" belt, takes 5 feet between centers.
1—18x8 Putnam, power and feed rest, 5 step cone.
3—21" Sidney Lathes, High Duty, D.B.G., C.R., P.C.F., H.S., 3 step cone, 4½" belt.
6—No. 7 Becker-Brainard Lyncoln Type Millers, fine condition.
1—No. 8 Duplex Becker-Brainard Lyncoln Type Miller.
1—No. 21 Garvin Plain Miller.

Simmons Machine Co., Inc., 981 Broadway, Albany, N.Y.

S. C. & H. REPUTATION

back of every Rebuilt Tool we sell. Our stock is large and varied, and constantly changing. Lathes, Turrets, Screw Machines, Grinders, Planers, Presses, Millers, Shapers, Drills, Radials.

Write Strong—Get Service.

The STRONG, CARLISLE & HAMMOND CO.
Cleveland - Detroit

Second Hand Drop Hammers

For Sale

Billings & Spencer patent, in good condition:

2—400 lb.
1—500 lb.
1—3500 lb.

Apply to

The Billings & Spencer Co.
Hartford, Conn.

Buyers Cyclopedia

Abrasive Materials
American Emery Wheel Works, Providence, R. I.
Carborundum Co., Niagara Falls, N. Y. New York City, Chicago, Boston, Phila., Cleveland, Cincinnati, Pittsburgh, Milwaukee, Grand Rapids, Manchester, Eng.; Dusseldorf, Germany.
Carborundum, Aloxite, garnet abrasive products. Carborundum and Aloxide grains, Carborundum paper and cloth, Aloxite cloth, garnet paper and cloth, Carborundum sharpening stones, rubbing bricks.
Dickinson, Thomas L., 64 Nassau St., N. Y. City.
Norton Co., Worcester, Mass., U. S. A. Cable: "Norco." Branches: New York, 151 Chambers St.; Chicago, 11 N. Jefferson St.; Niagara Falls, N. Y.; Chippewa, Ont., Canada; Bauxite, Ark.; Wesseling, Bz. Coln, Germany.
Alundum and Crystolon. Alundum is an artificial aluminous abrasive for grinding steel and steel alloys. Crystolon is a carbide of silicon abrasive, made in the electric furnace, for grinding cast, wrought or malleable iron, brass, bronze, aluminum, marble and materials of like physical characteristics.
Safety Emery Wheel Co., Larch St., Springfield, O. Agents: Farmer & Co., London; Adler Eisenchitz, Milan; Allied Machy. Co. of America, Paris.
Vitrified Wheel Co., Westfield, Mass.

Accumulators, Hydraulic
International Steam Pump Co., 115 Bway., N. Y. C.
Southwark Fdry. & Mach. Co., Philadelphia, Pa.
Watson-Stillman Co., 42 Church St., N. Y. City.

Air Lifts
Ingersoll-Rand Co., 11 Broadway, New York City.
International Steam Pump Co., 115 Bway., N. Y.
Sullivan Machinery Co., 122 S. Michigan Ave., Chicago, Ill.
Patented, improved foot-pieces, well heads and boosters.

Air Purifiers and Coolers
American Blower Co., 1400 Russell St., Detroit.
International Steam Pump Co., 115 Bway., N. Y. C.

Analyses, Chemical
Souther Engineering Corp., Hy., Hartford, Conn.

Arbors
Barber-Colman Co., Rockford, Ill.
Cincinnati Milling Machine Co., Oakley, Cincinnati, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Cushman Chuck Co., Hartford, Conn.
Detroit Twist Drill Co., 644 Fort St., Detroit.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
National Twist Drill & Tool Co., Detroit, Mich.
Pratt & Whitney Co., Hartford, Conn.
Pratt Chuck Co., Frankfort, N. Y.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Union Mfg. Co., New Britain, Conn.
Union Twist Drill Co., Athol, Mass.
Whitney Mfg. Co., Hartford, Conn. Cable: Whitney, Hartford.

Axles
Camden Forge Co., Mt. Ephraim Ave., Camden, N. J.

Balls, Brass and Bronze
Auburn Ball Bearing Co., 25 Elizabeth St., Rochester, N. Y.
Hoover Steel Ball Co., Ann Arbor, Mich.

Balls, Steel
Abbott Ball Co., Box 1233, Hartford, Conn.
Auburn Ball Bearing Co., 25 Elizabeth St., Rochester, N. Y.
Frasse & Co., Peter A., 417 Canal St., N. Y. C.
Hoover Steel Ball Co., Ann Arbor, Mich.
New Departure Mfg. Co., Bristol, Conn.

Barrels, Tumbling
Abbott Ball Co., Box 1233, Hartford, Conn.
Mott Sand Blast Co., 1157 E. 138th St., N. Y. C.
Royersford Fdry. & Mach. Co., Royersford, Penn.

Bars, Boring
Cleveland Twist Drill Co., Cleveland, Ohio.
Detrick & Harvey Mach. Co., Baltimore, Md.
Elmes Eng. Works, Chas. F., 1001 Fulton St., Chicago, Ill.
Marvin & Casler Co., Canastota, N. Y.
Underwood & Co., H. B., 1026 Hamilton St., Philadelphia, Penn.

Bars, Bronze Cored
American Bronze Co., Berwyn, Penn. 429 Ford Bldg., Detroit, Mich. Cable: Ambrocom, Phila.
All sizes "Non-Gran" bronze bars 12" long.
See advertisement on back cover.
Bunting Brass & Bronze Co., 726 Spencer St., Toledo, Ohio.

Bearings, Ball
Auburn Ball Bearing Co., 25 Elizabeth St., Rochester, N. Y.
Thrust and annular ball bearings to 26" diam.
Ball & Roller Bearing Co., Danbury, Conn.
Fafnir Bearing Co., The, New Britain, Conn. Detroit Office: 752 David Whitney Bldg.; Chicago Office: Cor. Clinton and Monroe St.
All sizes. Light, medium and heavy types. Radial ball bearings, single and double row. Ball thrust bearings. Angular contact bearings for combined radial and thrust loads. Cone or magneto type bearings.
Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, Penn. Cable: Hessbright.
Ball bearings made for heavy duty and high speeds, on both annular and thrust loads. Agents throughout the country.
New Departure Manufacturing Co., The, N. Main St., Bristol, Conn. Cable: Departure, Bristol. Branch: 1016-17 Ford Bldg., Detroit, Mich.
New Departure ball bearings in three types, double row, single row and radax.
Norma Co. of America, 1790 Broadway, New York. Cable: Normaco, New York.
Ball bearings of open separable type rigidly mounted. Thrust units made in both single and double types with or without housings.
S K F Ball Bearing Co., 50 Church St. New York City. Cable Address: Skayef, N. Y.
S K F are Swedish steel ball bearings, made at Gothenberg, Sweden. Self-aligning, permitting the shaft upon which they are mounted to deflect. Have a double row construction, two rows of balls to each bearings, the balls being held in staggered relation in the raceways.
U. S. Ball Bearing Mfg. Co., Oak Park, Ill. Cable: Ballbear.
Radial and thrust types.

Bearings, Die-Cast
Acme Die Casting Corp., Bush T. 5, Brooklyn.
Doehler Die Casting Co., Court and Ninth St., Brooklyn, N. Y. Branch: Toledo, Ohio. Cable: Doehler, Brooklyn.
Germann Bronze Co., 345 W. 19th St., Erie, Penn.
Light Manufacturing & Fdry. Co., Pottstown, Pa.
National Lead Co., Room 1901, 111 Bway., N. Y.

Bearings, Journal
American Bronze Co., Berwyn, Penn. 429 Ford Bldg., Detroit, Mich. Cable: Ambrocom, Phila.
Arguto Oilless Bearing Co., Philadelphia, Penn.
Bunting Brass & Bronze Co., 726 Spencer St., Toledo, Ohio.
Lumen Bearing Co., Buffalo, N. Y.

Bearings, Roller
Ball & Roller Bearing Co., Danbury, Conn.
Norma Co. of America, 1790 Brodaway, N. Y. C.
Royersford Fdry. & Mach. Co., Royersford, Penn.

Belt Cement
Graton & Knight Mfg. Co., Worcester, Mass.
Houghton & Co., E. F., 240 W. Somerset St., Philadelphia, Penn.
Schieren Co., Chas. A., 41 Ferry St., N. Y. City.

Belt Clamps
Billings & Spencer Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.

Belt Dressings and Fillers
Dixon Crucible Co., Joseph, Jersey City, N. J.
Graton & Knight Mfg. Co., Worcester, Mass.
Houghton & Co., E. F., 240 W. Somerset St., Philadelphia, Penn.
Rhoads & Sons, J. E., 32 N. 3d St., Phila., Pa.
Schieren Co., Chas. A., 41 Ferry St., N. Y City
Texas Company, Dept. A, 17 Battery Pl., N. Y. C.
White & Bagley Co, Worcester, Mass.
"Neverslip" belt dressing.

Belt Fasteners
Bristol Co., Waterbury, Conn.

Belt Lacing
Chicago (Ill.) Rawhide Mfg. Co., 1301 Elston Ave.
Graton & Knight Mfg. Co., Worcester, Mass.
Houghton & Co., E. F., 240 W. Somerset St., Philadelphia, Penn.
Rhoads & Sons, J. E., 32 N. 3d St., Phila., Pa.
Schieren Co., Chas. A., 41 Ferry St, N Y. City.
Southwick Co., The Geo., Stamford, Conn.

Belt Shifters
Le Blond Machine Tool Co., Cincinnati, Ohio.

Belt-Lacing Machines
Birdsboro Steel Fdry & Mach. Co., Birdsboro, Pa.

Belting, Chain
Caldwell Son Co., H. W., 17th St. and Western Ave., Chicago, Ill.
Link-Belt Co., 39th St. and Stewart Ave., Chicago, Ill. Philadelphia and Indianapolis.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Conn.

Belting, Leather
Chicago (Ill.) Rawhide Mfg. Co., 1301 Elston Ave.
Graton & Knight Mfg. Co., Worcester, Mass.
Get "Spartan Book No. 3."
Houghton & Co., E. F., 240 W. Somerset St., Philadelphia, Penn.
Rhoads & Sons, J. E., 32 N. 3d St., Phila., Pa.
Schieren Co., Chas. A., 41 Ferry St., N. Y. City

Benches, Work
Manufacturing Equipment & Engineering Co., 209 Washington St., Boston, Mass.
New Britain Machine Co., New Britain, Conn.
Western Tool & Mfg. Co., Springfield, Ohio.

Bench Legs
New Britain Machine Co., New Britain, Conn.
Pressed steel, electrically welded. Patented construction permits wide spacing without wall dependence.

Bending Machines, Power
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.
Sellers & Co., Inc., Wm., Philadelphia, Penn.

Blocks, Arbor Driving
Nicholson Co., W. H., 114 Oregon St., Wilkes-Barre, Penn.

Blocks, Chain (See Hoists, Hand)

Blocks, Die
Halcomb Steel Co., Syracuse, N. Y.

Blowers
American Blower Co., 1400 Russell St., Detroit.
American Gas Furnace Co., 24 John St., N. Y. C.
Ingersoll-Rand Co., 11 Broadway, New York City.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Penn.

Blue Printing Machines
Wickes Bros., Saginaw, Mich.

Bolt and Nut Machinery
Acme Machinery Co., Cleveland, Ohio.
Davis Machine Tool Co., Inc., 311 St. Paul St., Rochester, N. Y.
Detrick & Harvey Mach. Co., Baltimore, Md.
Foote-Burt Co., Cleveland, O. Cable: Footburt. Branches: Milwaukee, 436 Wells Bldg.; Detroit, 806 David Whitney Bldg.
Greenfield Tap & Die Corp., Greenfield, Mass.
Landis Machine Co., Waynesboro, Penn.
Sizes ½" to 2".
National Machinery Co., Tiffin, Ohio.
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.
Reed-Prentice Co., Worcester, Mass.
Standard Engineering Works, Ellwood City, Pa.
Victor Tool Co., Waynesboro, Penn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Bolts and Nuts
National-Acme Mfg. Co., Cleveland, Ohio.

Bone, Case Hardening
Houghton & Co., E. F., 240 W. Somerset St., Philadelphia, Penn.

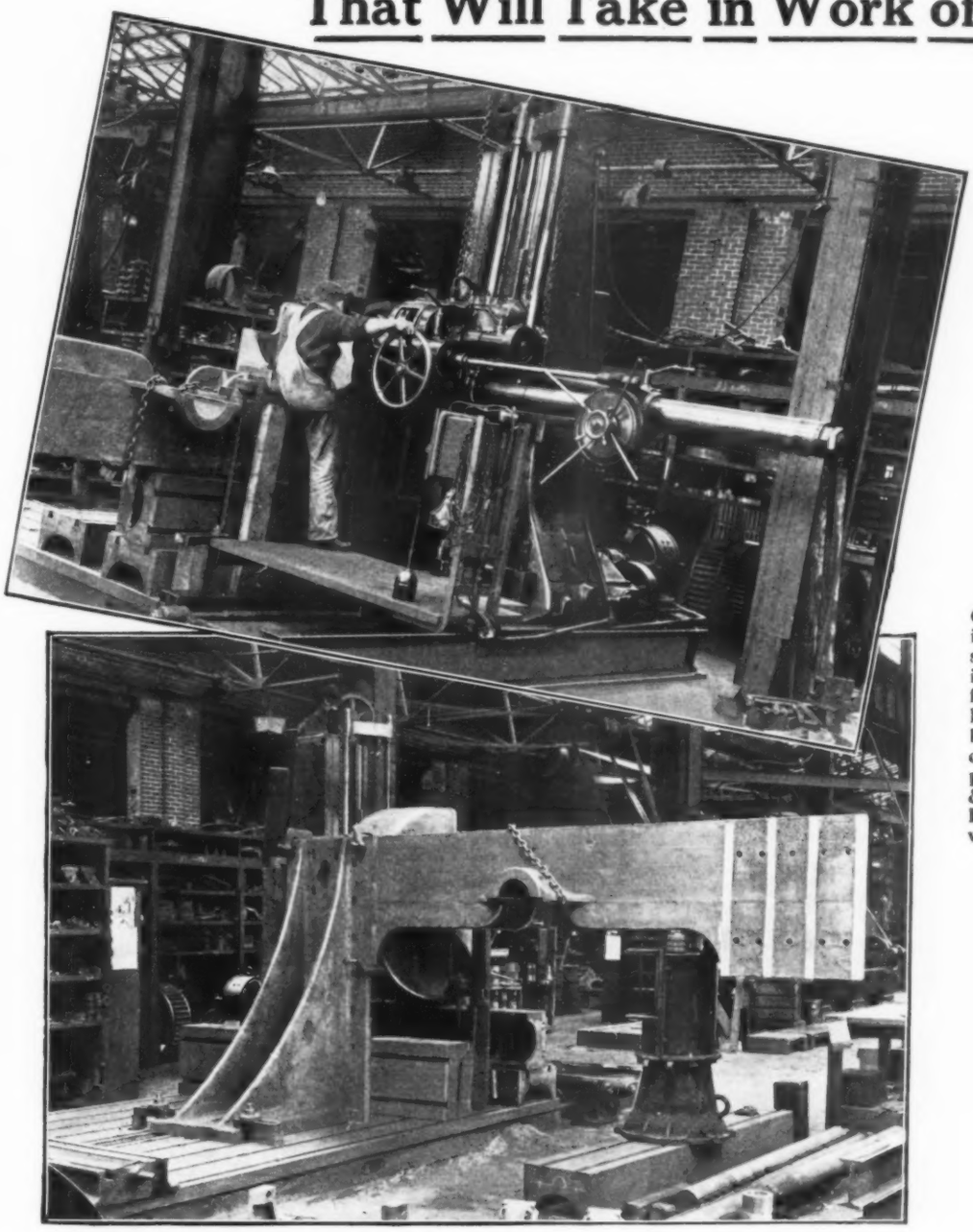
Books, Technical
McGraw-Hill Book Co., 239 W. 39th St., N. Y. C.

Boosters
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., Schenectady, N. Y.
Southwark Fdry. & Mach. Co., Philadelphia, Pa.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Penn.

Boring and Turning Mills, Vertical
Bickford & Co., H., Lakeport, N. H.
Five sizes, 4, 5, 6, 7 and 8 ft. siwng, either belt or motor driven, swivel heads. Power traverse if desired. Send for catalog.
Bullard Machine Tool Co., Bridgeport, Conn.
Cincinnati Planer Co., Cincinnati, Ohio.
Colburn Machine Tool Co., Franklin, Penn.
Sizes 30", 34", 42", 48", 54", 60", 72".
Detrick & Harvey Mach. Co., Baltimore, Md.
Mitts & Merrill, 913 Tilden St., Saginaw, Mich.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.

Boring, Drilling and Milling Machines, Horizontal
Amalgamated Machinery Corp., 72 W. Adams St., Chicago, Ill.

"The Only Machine We Have That Will Take in Work of This Kind



Casting is 16 ft. 5 in., 56 in. x 42 in. material—semi-steel. Weight 7180 lbs. It is the top of the cross frame for the world's heaviest wet grinding pan, being built by the American Clay Machinery Company, Bucyrus, Ohio. D. & H. Boring, Milling and Drilling Machine does the work!

"These photos show that in addition to doing regular line of work it is not only possible but practical to machine parts of unusual size on this type of machine. The "D. & H." stands up well and does its work in a manner entirely satisfactory to us. It is the only machine we have that will take in work of this kind."

Supt. **American Clay Machinery Company.**

This machine performs all operations—anything that falls under the classification of boring, milling and drilling—AT ONE SETTING. Easily handles castings of unusual size and shape.

Write NOW for bulletins.

Detrick & Harvey Machine Company
Baltimore, Md.

Baker Bros., Toledo, Ohio.
Barnes Co., W. F. & John, 1995 Ruby St., Rockford, Ill.
Beaman & Smith Co., Providence, R. I.
Detrick & Harvey Machine Co., Baltimore, Md. Cable: Detharvey.
Spindle 3½" to 8". Floor type only. Motor or belt drive. All gear feeds. Rapid power traverse. Rotary tables for hand or power and universal tilting table. Screw-cutting attachment can be furnished. Any size bed.
Foote-Burt Co., Cleveland, Ohio.
Fosdick Machine Tool Co., Cincinnati, Ohio.
Horizontal No. 0, spindle 3⅛.
Hoefer Mfg. Co., Freeport, Ill.
Lucas Machine Tool Co., E. 99th St. and N. Y. C. R.R., Cleveland, O. Cable: Lucas, Cleveland.
Three sizes, 3", 3¾" and 4½" spindles.
For boring, milling and drilling as separate operations, or all three operations, at one setting of the work.
National Automatic Tool Co., 7th and S. N St., Richmond, Ind. Cable: Natco, Richmond.
Horizontal multiple spindle drilling machines.
Three sizes, 2 to 150 spindles from 2 to 5 directions simultaneously.
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.
Pawling & Harnischfeger Co., Milwaukee, Wis.
Prentiss Tool & Supply Co., Singer Bldg., N. Y. C.
Springfield Machine Tool Co., Springfield, Ohio. Cable: Montanus. Spindle and axle boring machines, 2 sizes, 7"x60" and 11"x84".
Universal Boring Machine Co., Hudson, Mass., U. S. A. Cable: "Horizontal," Hudson.
No. 3-A Universal (horizontal) boring machine has 3" main boring bar with 28" continuous feed table 24" by 48" with 36" power crossfeed. No. 3½ Universal (horizontal) boring machine has 3½" main boring bar with 30" continuous feed, 30" vertical movement. Table 30" by 48" with 36" power crossfeed.
Vandyck Churchill Co., 93 Liberty St., N. Y. C.

Boring Heads
Marvin & Casler Co., Canastota, N. Y.
Radical Boring Head Corp., 90 West St., N. Y. C.
Taft-Peirce Mfg. Co., Woonsocket, R. I.

Boring Tools
Madison Mfg. Co., Muskegon, Mich.
Rigid Tool Holder Co., Baltimore, Md.
Western Tool & Mfg. Co., Springfield, Ohio.
Williams Co., J. H., 35 Richards St., Brooklyn.

Boxes, Tote (See Furniture, Machine Shop)

Broaches
Lapointe Co., J. N., New London, Conn. Cable: Lapointe, New London.
Lapointe Machine Tool Co., Hudson, Mass.
For any class of work, for use on any broaching or keyseating machine.
Send for Catalog "C."
Taft-Peirce Mfg. Co., Woonsocket, R. I.

Broaching Machines
Lapointe Co., J. N., New London, Conn. Cable: Lapointe, New London.
Five sizes.
No. 0 machine, capacity to cut keyways ¼" wide by 2" long, sq. holes ½" sq. by 1" long. No. 1 machine, keyways ⅜" wide by 3" long, sq. holes ¾" sq. by 1½" long. No. 2 machine, keyways ¾" wide by 8" long, sq. holes 1½" sq. by 4" long. No. 3 machine, keyways 1½" wide by 10" long, sq. holes 3" sq. by 6" long. No. 4, keyways 2½" wide by 20" long, sq. holes 5" sq. by 12" long.
Lapointe Machine Tool Co., Hudson, Mass. Cable: "Lapointe, Hudson."
Four sizes—No. 1, square holes up to ¾"; No. 2, square holes up to 1¼"; No. 3, square holes up to 3"; No. 4, square holes up to 4". Round or irregular shapes of larger sizes can be handled. Send for Catalogue C.

Bronze
American Bronze Co., Berwyn, Penn. 429 Ford Bldg., Detroit, Mich. Cable: Ambrocom, Phila. "Non-Gran" high-speed bearing bronze for solid nonadjustable bronze bushings.
See advertisement on back cover.

Brushes
Dixon Crucible Co., Joseph, Jersey City, N. J.

Buffing or Polishing Machines
Barnes Co., W. F. & John, 1995 Ruby St., Rockford, Ill.
Besly & Co., Chas. H., 18 N. Clinton St., Chicago, Ill.
Blake & Johnson Co., The, Waterbury, Conn.
Blount Co., J. G., Woodland St., Everett, Mass.
Bryant Chucking Grinder Co., Springfield, Vt.
Diamond Machine Co., Providence, R. I.
Forbes & Myers, 172 Union St., Worcester, Mass.
Greenfield Machine Co., Greenfield, Mass.
Heald Machine Co., 10 New Bond St., Worcester, Mass.
Landis Tool Co., Waynesboro, Penn. Cable: Landis, Waynesboro.
Types—Universal and plain cylindrical, internal, crank, roll, ball bearing race grinding machines.
New Britain Mach. Co., New Britain, Conn.
Plain and ball bearing, drop head, down-belted floor and bench types.
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.
Norton Grinding Co., Worcester, Mass.
Rowbottom Machine Co., Waterbury, Conn.
Royersford Fdry. & Mach. Co., Royersford, Penn.
Safety Emery Wheel Co., Larch St., Springfield, O.
Union Twist Drill Co., Athol, Mass.
U. S. Electrical Tool Co., Cincinnati, Ohio.
Van Dorn Electric Tool Co., Cleveland, Ohio.
Van Norman Machine Tool Co., Wilbraham Ave., Springfield, Mass.
Vitrified Wheel Co., Westfield, Mass.
Walker & Co., O. S., Worcester, Mass.
Wells & Son Co., F. E., Greenfield, Mass.
Wilmarth & Morman Co., 1187 Monroe Ave., Grand Rapids, Mich.

Bulldozers
Toledo Machine & Tool Co., Toledo, Ohio.

Bushings
American Bronze Co., Berwyn, Penn. 429 Ford Bld., Detroit, Mich. Cable: Ambrocom, Phila. All sizes Non-Gran cored and solid bars 12" long. Also castings and bushings.
See advertisement on back cover.
Bunting Brass & Bronze Co., 726 Spencer St., Toledo, Ohio.
Phosphor Bronze Smelting Co., 2200 Washington Ave., Philadelphia, Penn.

Calipers
Athol Machine Co., Athol, Mass.
Randall & Stickney, Waltham, Mass.
Reed & Prince Mfg. Co., Worcester, Mass.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.
Williams Co., J. H., 35 Richards St., Brooklyn.

Cam Cutting Machines
Garvin Mach. Co., Spring and Varick St., N. Y. C.
Rowbottom Machine Co., Waterbury, Conn.
For cutting all kinds of cams in general use.
Taft-Peirce Mfg. Co., Woonsocket, R. I.

Cams
Boston Gear Works, Norfolk Downs, Mass.
Rowbottom Machine Co., Waterbury, Conn.
All kinds, all sizes to order.

Can-Making Machinery (See Sheet Metal Working Machinery)

Cars, Industrial
Link-Belt Co., 39th St. and Stewart Ave., Chicago, Ill. Philadelphia and Indianapolis.

Castings, Aluminum
Acme Die Casting Co., Bush. T. 5, Brooklyn.
American Die Castings Co., 39 S. 6th St., Newark, N. J.
Bunting Brass & Bronze Co., 726 Spencer St., Toledo, Ohio.
Doehler Die Casting Co., Court and Ninth St., Brooklyn, N. Y. Branch: Toledo, Ohio. Cable: Doehler, Brooklyn.
Germann Bronze Co., 345 W. 19th St., Erie, Pa.
Light Manufacturing & Fdry. Co., Pottstown, Pa.

Castings, Brass and Bronze
American Bronze Co., Berwyn, Penn.
Bunting Brass & Bronze Co., 726 Spencer St., Toledo, Ohio.
Germann Bronze Co., 345 W. 19th St., Erie, Pa.
Imperial Brass Mfg. Co., 1214 W. Harrison St., Chicago, Ill.
Light Manufacturing & Fdry Co., Pottstown, Pa.
Phosphor Bronze Smelting Co., 2200 Washington Ave., Philadelphia, Penn.
Stewart Mfg. Co., J. K., Wells St. Bridge, Chicago, Ill.

Castings, Die Molded
Acme Die Casting Co., Bush T. 5, Brooklyn.
American Die Castings Co., 39 S. 6th St., Newark, N. J.
Doehler Die Casting Co., Court and Ninth St., Brooklyn, N. Y. Branch: Toledo, Ohio. Cable: Doehler, Brooklyn.
Die castings in aluminum, zinc, tin and lead alloys.
Franklin Mfg. Co., 400 S. Geddes St., Syracuse, N. Y. Cable: Franklin.
Die cast parts in aluminum, zinc, tin and lead base alloys.
Germann Bronze Co., 345 W. 19th St., Erie, Pa.
Light Manufacturing & Fdry. Co., Pottstown, Pa.
Moberg, Inc., C. J., Mt. Vernon, N. Y.
National Lead Co., Rm. 1901, 111 Bway., N. Y. C.
Phoenix Die Casting Co., 21 Illinois St., Buffalo.
Stewart Mfg. Co., J. K., Wells St. Bridge, Chicago, Ill.

Castings, Iron
Athol Machine Co., Athol, Mass.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Farrel Foundry & Machine Co., Ansonia, Conn.
Holyoke Machine Co., Worcester, Mass.
Stewart Mfg. Co., J. K., Wells St. Bridge, Chicago, Ill.
Taylor & Fenn Co., The, Hartford, Conn.

Castings, Semi-Steel
Farrel Foundry & Machine Co., Ansonia, Conn.

Castings, Steel
Cincinnati Steel Castings Co., Cincinnati, Ohio.
Stewart Mfg. Co., J. K., Wells St. Bridge, Chicago, Ill.
West Steel Casting Co., Cleveland, Ohio.

Cements, Belt
Graton & Knight Mfg. Co., Worcester, Mass.
Schieren Co., Chas. A., 41 Ferry St., N. Y. City.

Cements, Iron
Felton, Sibley & Co., Inc., 136 N. 4th St., Phila.
Moller & Schumann Co., 8 Gerry St., Brooklyn.
Smooth-On Mfg. Co., Jersey City, N. J.

Centering Machines
Detrick & Harvey Machine Co., Baltimore, Md. Cable: Detharvey.
For heavy forgings and guns. 2" to 14" swing.
Hendey Machine Co., Torrington, Conn.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.
Wells & Son Co., F. E., Greenfield, Mass.
Whiton Mach. Co., D. E., New London, Conn.

Centers, Planer
Cincinnati Planer Co., Cincinnati, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Woodward & Powell Planer Co., Worcester, Mass.

Chains (See Sprockets and Chains)

Chains, Driving
Baker Bros., Worcester, Mass.
Frasse Co., Peter A., 417 Canal St., N. Y. City. 52 Exchange St., Buffalo; 623 Arch St., Phila. American agents for "Renold" chains.
Link-Belt Co., Nicetown, Phila., Pa. New York, Pittsburgh, Boston, St. Louis, Buffalo, Wilkes-Barre, Detroit, Cleveland, Seattle, Portland, Ore.; Los Angeles, Denver, Minneapolis, New Orleans, San Francisco, Birmingham, Toronto. Link-Belt silent chain.
Send for 112-page data book No. 125.
Morse Chain Co., Ithaca, N. Y., U. S. A. Branches: New York, Boston, Chicago, Pittsburgh, Cleveland, San Francisco, St. Louis, Atlanta Minneapolis, Detroit, U. S. A.
Sizes—⅜" to 3" in pitch, widths to suit powers. Capacities—¼ hp. to 5,000 hp.
Morse "Rocker-Joint" (rolling friction principle) silent type chains exclusively, for the transmission of power for any purpose.
Licensees for Europe: Westinghouse Brake Co., Ltd., 32 York Rd., Kings Cross, London, N.
Whitney Mfg. Co., Hartford, Conn. Cable: Whitney, Hartford.

Chasers
Landis Machine Co., Waynesboro, Penn.

Chemists
Souther Engineering Corp., Hy., Hartford, Conn.

Chip Handling Systems
American Blower Co., 1400 Russell St., Detroit.

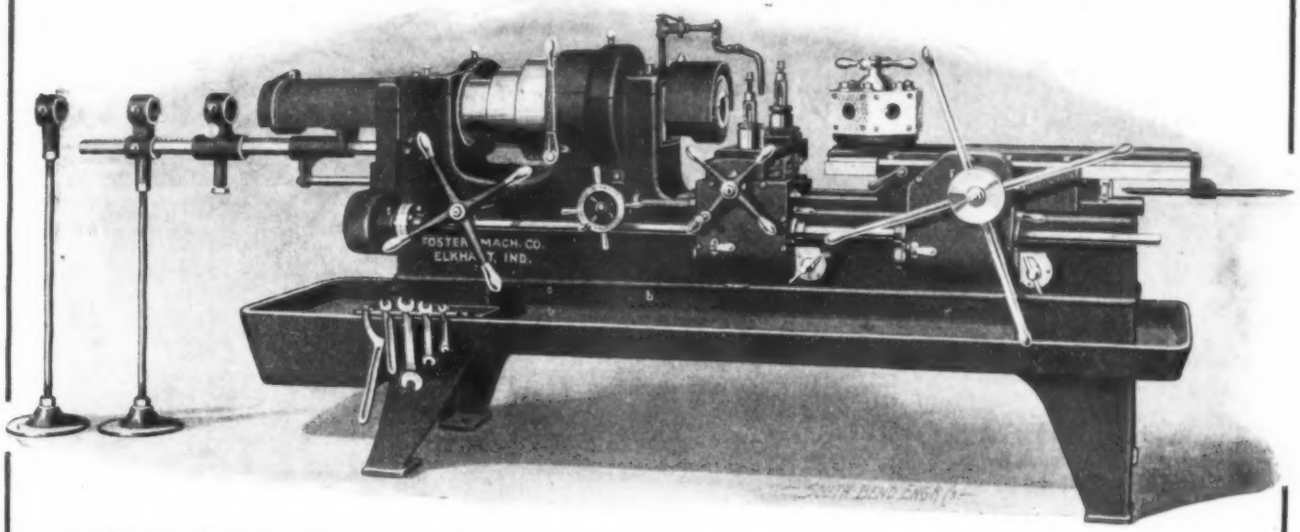
Chucking Machines, Automatic
Bullard Machine Co., Bridgeport, Conn.
New Britain Machine Co., New Britain, Conn. 2008 W. Grand Blvd., Detroit.
Two types, single head and double head. Single head, four and five spindles, four sizes. Double head, six and eight spindles, three sizes. For chucking castings, forgings and second operation bar work.
Agents: Alfred H. Schutte, Cologne and Berlin; Coates Machine Tool Co., Ltd., Caxton House, London; Donawerk, Ernest Krause & Co., Wien, Prague and Budapest.
Potter & Johnston, Pawtucket, R. I.
"P. J. Manufacturing Automatics." 4 sizes, 5A, 6A, 7A, 8A. Range of work varies from about 2½ diam. to 40" diam.
Windsor Machine Co., Windsor, Vt., U. S. A. Cable: Machine, Windsor, Vt.
Gridley single-spindle automatic. Three sizes, handling bars not larger than 2¼", 3¼" and 4¼" in diameter. Have only one spindle, which revolves without change of position, while the turret with the attached slides on which the tools are mounted is revolved step by step on a horizontal axis, bringing each slide with its tools into working position, and by the movement of the individual turret tool slides the tools are brought into contact with the work.

Chucking Machines (See Lathes, Horizontal Turret)

Chucks, Centering
Carroll-Jamieson Machine Co., Davis Ave., Batavia, Ohio.
Cushman Chuck Co., The, Hartford, Conn. New York, San Francisco.
One size. Used on bench for centering short pieces from ¼" to 1½" diameter.

Chucks, Drill and Tap
Almond, T. R., 6 Maple Ave., Ashburnham, Mass.
Automatic Drill Chuck Corp'n, Majestic Bldg., Detroit, Mich.
Sizes No. 6, ⅛ in. to ¾ in.; No. 8, $\frac{3}{16}$ in. to ½ in. No key, collets, etc. Self-centering.
Celfor Tool Co., Buchanan, Mich.
Cleveland Twist Drill Co., Cleveland, Ohio.
Cushman Chuck Co., The, Hartford, Conn. New York, San Francisco.
Six sizes and 2 styles holding from 0 to 1" diameter drills, rods, etc. 3-jaw and 4-jaw type.
Detroit Twist Drill Co., 644 Fort St., Detroit.

Just a glance is not enough—Study this



FOSTER Geared Friction Head Screw Machine

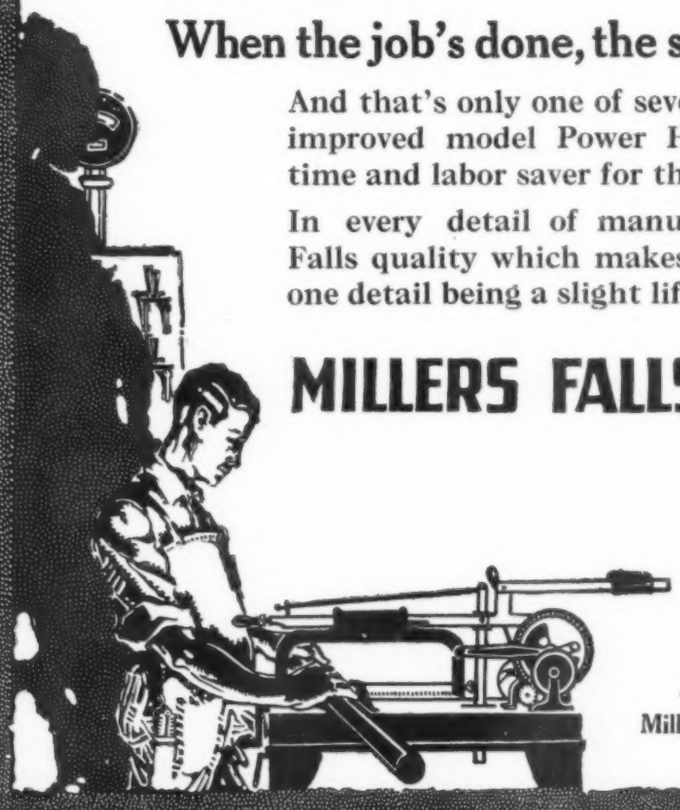
It must be studied to be appreciated.

Note the Square Adjustable boxes in the Headstock for re-adjusting the spindle alignment. And the Hand Longitudinal Feed to the Cut-Off Slide and Hexagon Turret.

Then there are quick change gears to the Power Feed to the Turret Slide, giving six feeds and quick change gears to the Cut-Off Slide, giving four feeds in both directions.

A study of the Circular F. 9 will be profitable. Send for it today.

Foster Machine Company, Elkhart, Indiana, U. S. A.



When the job's done, the saw stops automatically

And that's only one of several good features of this improved model Power Hack Saw. It's a great time and labor saver for the busy workman.

In every detail of manufacture there is Millers Falls quality which makes for a long useful life—one detail being a slight lift on the back stroke.

MILLERS FALLS Power Hack Saw NO. 90

Gear drive assures a steady stroke. Return movement twice as quick as cutting stroke. Height from floor to bed 28 inches. Floor space 20x46 inches. Capacity 5x5 inches, only ½ h. p. required. See one at your dealer's. Write for handy pocket catalogue. Star Hack Saw Blades are the best.

Millers Falls Co.

"Toolmaker to the Master Mechanic"

Millers Falls, Mass. N.Y. Office, 28 Warren St.

Greenfield Tap & Die Corp., Greenfield, Mass.
Gronkvist Drill Chuck Co., 18 Morris St., Jersey City, N. J.
"Gronkvist" automatic 5, "Kupke" keyless 3.
Horton & Son Co., E., Windsor Locks, Conn.
Millers Falls Co., Millers Falls, Mass.
Modern Tool Co., 4th and French St., Erie, Penn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
National Twist Drill & Tool Co., Detroit, Mich.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, Ohio.
Union Mfg. Co., New Britain, Conn.
Victor Tool Co., Waynesboro, Penn.
Wahlstrom Tool Co., Brooklyn, N. Y.
Whitney Mfg. Co., Hartford, Conn. Cable: Whitney, Hardford.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Lathe
Cushman Chuck Co., The, Hartford, Conn. New York, San Francisco.
38 styles. 27 sizes from 2" to 36".
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Trademark, "Sweetland."
Horton & Son Co., E., Windsor Locks, Conn.
Jones & Lamson Mach. Co., Springfield, Vt.
Millers Falls Mfg. Co., Millers Falls, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Conn.
Warner & Swasey Co., Cleveland, Ohio.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Magnetic
D & W Fuse Co., Providence, R. I. Cable: Nonarching.
A flat, rotary, vertical, swiveling, waterproof, heatproof, equipped with demagnetizing switch.
Heald Machine Co., 10 New Bond St., Worcester, Mass.
Walker Co., O. S., Worcester, Mass.

Chucks, Planer
Cincinnati Planer Co., Cincinnati, Ohio.
Cushman Chuck Co., Hartford, Conn.
D & W Fuse Co., Providence, R. I.
Horton & Son Co., E., Windsor Locks, Conn.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Conn.
Walker Co., O. S., Worcester, Mass.

Chucks, Split
Ames Co., B. C., Waltham, Mass.
Rivett Lathe & Grinder Co., Brighton, Boston, Mass. Cable Address: Edrivett.
Ten sizes. Capacity up to 1" diameter hole.
Tool steel split chucks.
See our advertisement on inside of back cover.
Stark Tool Co., Waltham, Mass.

Clamps, Machinists'
Armstrong Bros. Tool Co., 315 N. Francisco Ave., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Hammacher, Schlemmer & Co., 13th St. and 4th Ave., New York City.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Starrett Co., L. S., Athol, Mass.
Western Tool & Mfg. Co., Springfield, Ohio.
Williams Co., J. H., 35 Richards St., Brooklyn.

Clocks, Time
Calculagraph Co., 1438 Jewelers Bldg., N. Y. C.

Clutches, Friction
Automatic Shaft Coupling Co., Alexandria, Va.
Brown Co., A. & F., 79 Barclay St., N. Y. City.
Caldwell Son Co., H. W., 17th St. and Western Ave., Chicago, Ill.
Edgemont Machine Co., Champie and National Ave., Dayton, Ohio.
Evans Friction Cone Co., 1288 Centre St., Newton Centre, Mass.
Holyoke Machine Co., Worcester, Mass.
Johnson Mach. Co., Carlyle, 52 Main St., Manchester, Conn. Cable: Carlyle, Hartford.
5 sizes both single and double, capacities up to 3" diam. shafting. Weight 12 to 100 lb. Price $10 to $75. For use on overhead shafting with or without pulleys, and as a one-way cut-off coupling to connect ends of two shafts.
Agents: The Efandem Co., 159 Gt. Portland St., London, W., Eng.; Wilhelm Sonesson, Malmo, Sweden; Schuchardt & Schutte, Berlin, Germany; Glaezner & Perreaud, Paris, France.
Link-Belt Co., 39th St. and Stewart Ave., Chicago, Ill. Philadelphia and Indianapolis.
Reliance Gauge Column Co., 6009 Carnegie Ave., Cleveland, Ohio.

Coal Handling Machinery
Caldwell & Co., Inc., W. E., Lousville, Ky.
Link-Belt Co., 39th St. and Stewart Ave., Chicago, Ill. Philadelphia and Indianapolis.

Coilers, Spring
Garvin Mach. Co., Spring and Varick St., N. Y. C.

Coils, Electrical
D & W Fuse Co., Providence, R. I.
General Electric Co., Schenectady, N. Y.

Collets
Pratt & Whitney Co., Hartford, Conn.
Union Twist Drill Co., Athol, Mass.
Whitney Mfg. Co., Hartford, Conn. Cable: Whitney, Hartford.

Compounds, Carbonizing, Casehardening and Tempering
American Comp. Co., 151 Franklin St., Boston.
Rogers & Hubbard Co., Middletown, Conn.
Shore Instrument & Mfg. Co., 555 W. 22nd St., New York. "Enamellite."

Compounds, Cleaning
White & Bagley Co., Worcester, Mass.

Compounds, Cutting, Drilling, Grinding and Screw Cutting
Crescent Oil Co., 30 Church St., New York City.
Houghton & Co., E. F., 240 W. Somerset St., Philadelphia, Penn.
Oil City Oil & Grease Co., Oil City, Penn.
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"Pensoil" mineralized lard oil.
Texas Company, Dept. A, 17 Battery Place, N. Y.
White & Bagley Co., Worcester, Mass.
"Economy" cutting lubricant. "Economy" grinding lubricant. "Minolard" cutting oil for automatics.

Compounds, Pipe-Joint
Smooth-On Mfg. Co., Jersey City, N. J.

Compressors, Air and Gas
Blanchard Machine Co., Cambridge, Mass.
Chicago Pneumatic Tool Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Ingersoll-Rand Co., 11 Broadway, New York. Branches: Boston, Birmingham, Butte, Cleveland, Chicago, Denver, Duluth, El Paso, Knoxville, Los Angeles, Phila., Pittsburgh, St. Louis, Seattle.
International Steam Pump Co., 115 Bway., N. Y. C.
Southwark Fdry. & Mach. Co., Philadelphia, Pa
Sullivan Mchy. Co., 122 S. Michigan Av., Chicago
Steam and power drive, any capacity, any pressure.

Conduits, Interior
General Electric Co., Schenectady, N. Y.

Cones, Friction
Evans Friction Cone Co., 1288 Centre St., Newton Centre, Mass.

Connecting-Rods and Straps
Standard Gauge Steel Co., Beaver Falls, Penn.

Contract Work
American Machine & Fdry. Co., 353 Carroll St., Brooklyn, N. Y. New York Office: 200 5th Ave.
Blanchard Machine Co., 64 State St., Cambridge, Mass.
Columbus Die Tool & Mach. Co., Columbus, Ohio.
Cowdrey Mach. Wks., C. H., Fitchburg, Mass.
Garvin Mach. Co., Spring and Varick St., N. Y. C.
Grant Mfg. & Machine Co., 85 Silliman Ave., Bridgeport, Conn.
Harris Engineering Co., H. E., Bridgeport, Conn.
Holyoke Machine Co., Worcester, Mass.
Mailometer Co., Detroit, Mich.
Meisel Press Mfg. Co., 946 Dor. Ave., Boston.
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.
Reynolds Pattern & Machine Co., Moline, Ill.
Rowbottom Machine Co., The, Waterbury, Conn.
Taft-Peirce Mfg. Co., Woonsocket, R. I. Majestic Bldg., Detroit; Woolworth Bldg., N. Y. City.
All kinds of machines, machine parts and tools. Design and build tool equipments, jigs, fixtures.

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General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Penn.

Cotter Pins
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, Ohio.

Counterbores
Cleveland Twist Drill Co., E. 49th St. and Lakeside Ave., Cleveland, Ohio. New York: 30 Reade St.; Chicago, 9 N. Jefferson St.
Detroit Twist Drill Co., 644 Fort St., Detroit.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
National Twist Drill & Tool Co., Detroit, Mich.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Providence, R. I.

Counters, Revolution
Bristol Co., Waterbury, Conn.
New Haven Trolley Supply Co., New Haven, Conn.
Root Co., C. J., 100 Stone St., Bristol, Conn.
Stewart-Warner Speedometer Corp., Chicago, Ill.
Veeder Mfg. Co., 15 Sargeant St., Hartford, Conn.

Countershafts
Garvin Mach. Co., Spring and Varick St., N. Y. C.
Norton Grinding Co., Worcester, Mass.
Warner & Swasey Co., Cleveland, Ohio.

Counting and Printing Wheels
Doehler Die Casting Co., Court and Ninth St., Brooklyn, N. Y. Branch; Toledo, Ohio. Cable: Doehler, Brooklyn.
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National Scale Co., Montgomery St., Chicopee Falls, Mass.
22 sizes, for counting parts and pieces ranging from 25,000 to the ounce, to pounds, to the piece, loads aggregating 5 tons.

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Automatic Shaft Coupling Co., Real Estate Trust Bldg., Washington, D. C.
Almond, T. R., 6 Maple Ave., Ashburnham, Mass.
Clark Flexible Coupling Co., 27 Walker St., N. Y.
Edgemont Machine Co., Champie and National Ave., Dayton, Ohio.
Independent Pneumatic Tool Co., Thor Bldg., Chicago, Ill.
Nicholson Co., W. H., 144 Oregon St., Wilkes-Barre, Penn.
Standard Gauge Steel Co., Beaver Falls, Penn.

Cranes, Portable
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Cleveland Crane & Engineering Co., Wickliffe, O.
Electric or hand power. 5 to 200 tons capacity.
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Southwark Fdry. & Mach. Co., Philadelphia, Pa.
Vandyck Churchill Co., 93 Liberty St., N. Y. C.
Yale & Towne Mfg. Co., 9 E. 40th St., N. Y. City.

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Cleveland Crane & Engineering Co., Wickliffe, O.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.
Underwood & Co., H B., 1026 Hamilton St., Philadelphia, Penn

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Dixon Crucible Co., Joseph, Jersey City, N. J.

Cupolas and Ladles
Paxson Co., J. W., 1021 N. Delaware Ave., Phila.

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Barber-Colman Co., Rockford, Ill.
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45 styles. Nearly 5,000 sizes in stock in both carbon and high-speed steels. Special cutters singly or in gangs to order.
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Detroit Twist Drill Co., 644 Fort St., Detroit.
Ingersoll Milling Machine Co., The, Rockford, Ill.
Standard cutters. Special cutters developed.
Ask for catalogue No. 30-C.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
National Twist Drill & Tool Co., Detroit, Mich.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, Ohio.
Union Twist Drill Co., Athol, Mass.
Whitney Mfg. Co., Hartford, Conn.

Cutting-Off Machines
Cochrane Bly Co., Rochester, N. Y.
Davis Machine Tool Co., Inc., 311 St. Paul St., Rochester, N. Y.
Detrick & Harvey Mach. Co., Baltimore, Md.
Garvin Mach. Co., Spring and Varick St., N. Y. C.
Gorton Machine Co., Geo., Racine, Wis.
Hurlbut, Rogers Machinery Co., South Sudbury, Mass. Cable: "Hurlbut."
Two styles, cone and accelerated. Seven sizes, 2" to 10".
Landis Machine Co., Waynesboro, Penn.
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.
Nutter & Barnes Co., Hinsdale, N. H. 13 South Clinton St., Chicago, Ill.
Will handle bar metal in single pieces or multiples up to 10-10" round or square.
Vandyck Churchill Co., 93 Liberty St., N. Y. C.

Cutting-Off Machines, Pipe
(See Pipe Cutting and Threading Machines)

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Oxweld Acetylene Co., Chicago, Ill.
Pratt & Whitney Co., Hartford, Conn.
Rigid Tool Holder Co., Baltimore, Md.
Western Tool & Mfg. Co., Springfield, Ohio.

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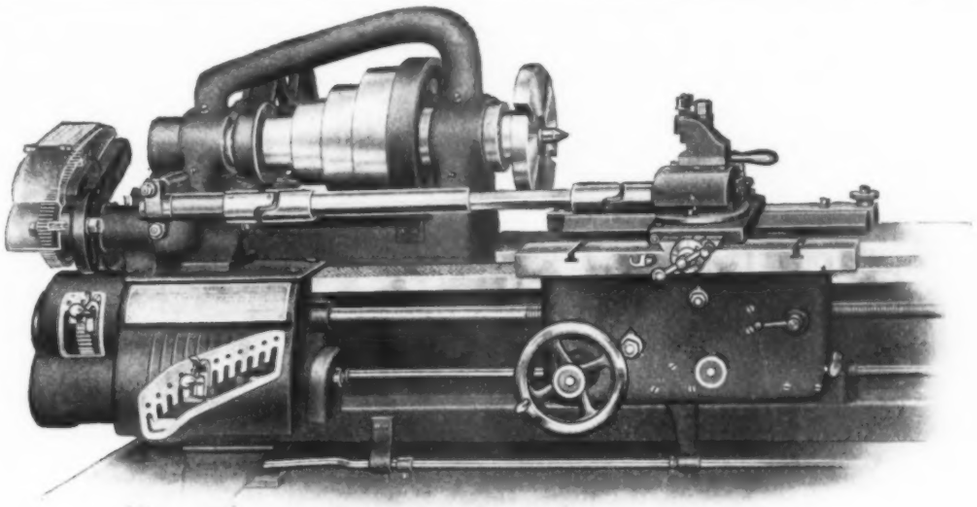
Davis-Bournonville Co., Jersey City, N. J.
International Oxygen Co., 115 Broadway, N. Y.
Oxweld Acteylene Co., Chicago, Ill.

Cut-Outs, Electrical
D & W Fuse Co., Providence, R. I.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa

Dealers, Machinery
Garvin Mach. Co., Spring and Varick St., N. Y. C.
Hill, Clarke & Co., 156 Oliver St., Boston, Mass.
Prentiss Tool & Supply Co., Singer Bldg., N. Y. C.
Strong, Carlisle, Hammond Co., Cleveland, Ohio.
Toomey, Inc., Frank, Philadelphia, Penn.
Vandyck Churchill Co., 93 Liberty St., N. Y. C.

Diamond Tools
Crafts, Arthur A., 125 Summer St., Boston, Mass.
Dickinson, Thomas L., 64 Nassau St., N. Y. City.

Die Machines
Anderson Die Machine Co., Bridgeport, Conn.
For blanking dies and similar work. Constant cut. No feed screws, slides or vises required.



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The simplicity of Hendey Attachments is exemplified in our Type C Relieving Attachment for the lathe. The actuating mechanism is mounted on main gear box, displacing tool pan or cover of same.

The tool slide interchanges with the compound or other rest on top of cross slide and incorporates the natural advantages of the swiveling feature on slide to secure suitable positions for side and end reliefs.

The whole attachment can be placed in working position in a very few minutes.

Read all about Hendey Relieving Attachments in our latest Catalog. Write for a copy.

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Detroit, W. M. Pattison Supply Co., Dime Bank Building
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Philadelphia, Sherritt & Stoer Co.
Syracuse, Syracuse Supply Co.
Buffalo, Syracuse Supply Co., Mutual Life Building.
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Export Agents: Charles Churchill & Co., Ltd., London, Glasgow, Birmingham, Manchester.

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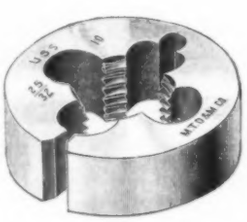

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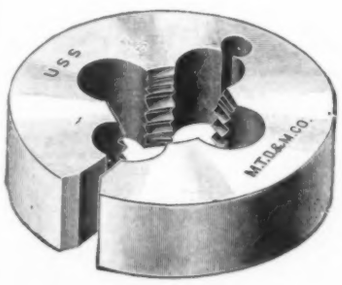
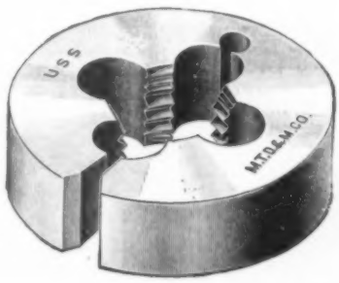
Sold singly or in sets of standard threads.



Catalog.

Morse Twist Drill & Machine Company
New Bedford, Massachusetts



Dies, Pipe Threading
Bignall & Keeler Mach. Wks., Edwardsville, Ill.
Greenfield Tap & Die Corp., Greenfield, Mass.
Landis Machine Co., Waynesboro, Penn.
Sizes 1" to 18".
Wells & Son Co., F. E., Greenfield, Mass.

Dies, Sheet-Metal
Columbus Die Tool & Mach. Co., Columbus, Ohio
Ferracute Mach. Co., Bridgeton, N. J.
Gem City Machine Co., Dayton, Ohio.
Mailometer Co., Detroit, Mich.
Modern Tool Die & Mach. Co., Columbus, Ohio.
Niagara Mach. & Tool Works, Buffalo, N. Y.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Toledo Machine & Tool Co., Toledo, Ohio.
Waltham Mach. Works, High St., Waltham, Mass.

Dies, Sub-Press
Columbus Die Tool & Mach. Co., Columbus, Ohio.
Gem City Machine Co., Dayton, Ohio.
Mailometer Co., Detroit, Mich.
Modern Tool Die & Machine Co., Columbus, Ohio.
Nelson Tool Co., Inc., 781 E. 142nd St., N. Y. C.
Pratt & Whitney Co., Hartford, Conn.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Waltham Mach. Works, High St., Waltham, Mass.

Dies, Threading-Opening
Eastern Machine Screw Corp., New Haven, Conn.
Errington, F. A., 39 Cortlandt St., New York City.
Geometric Tool Co., New Haven, Conn. 545 W. Washington Blvd., Chicago, Ill. Cable: Metric. For all classes of external screw threads of any diameter, length and form.
Greenfield Tap & Die Corp., Greenfield, Mass.
Jones & Lamson Machine Co., Springfield, Vt., U. S. A. Cable: Turret. Branch: Jones & Lamson Mach. Co., 97 Queen Victoria St., London, E. C.
Sizes: Nos. 1, 3, 4, 6 and 9 dies. Capacities: ⅞", 1¼", 1½", 2" and 3" respectively.
An automatic opening die for use on turret lathes, automatic screw machines, engine lathes, drill presses, etc. Has wide range. Fine threads can be cut with large dies without stripping. Chasers have special lead control feature, giving accurate pitch.
Foreign Agents: Germany, Switzerland, Austria-Hungary, M. Koyeman, Charlottenstrasse 11, Dusseldorf, Germany; France, Spain, Belgium, F. Auberty & Co., 91 Rue de Maubeuge, Paris. Domestic Agents: E. A. Kinsey Co., Cincinnati, O.; E. A. Kinsey Co., Indianapolis, Ind.; Boyer-Campbell Co., Detroit, Mich.; E. L. Essley Machinery Co., Chicago, Ill.; Robinson, Cary & Sands Co., St. Paul, Minn.; Carey Mchy. & Supply Co., Baltimore, Md.; W. M. Pattison Supply Co., Cleveland, O.; Barwood-Richards Machy. Co., The Bourse, Philadelphia, Penn.
Landis Machine Co., Waynesboro, Penn.
Sizes 1" to 18".
Modern Tool Co., 4th and French St., Erie, Penn. Chicago, 32 N. Clinton St.; Detroit, 127 Rosedale Court. Cable: Moderntool.
"Modern" self-opening adjustable die heads. 16 sizes, capacity ⅛" to 6" diam.
Murchey Mach. & Tool Co., 64 Porter St., Detroit.
National-Acme Mfg. Co., Cleveland, Ohio.
National Machinery Co., Tiffin, Ohio.
Warner & Swasey Co., Cleveland, Ohio.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Disinfectants
Houghton & Co., E. F., 240 W. Somerset St., Philadelphia, Penn.

Dogs, Lathe and Milling Machines
Hammacher, Schlemmer & Co., 13th St. and 4th Ave., New York City.
Page-Storms Drop Forge Co., Chicopee, Mass.
Williams Co., J. H., 35 Richards St., Brooklyn.

Dressers, Grinding Wheel
American Emery Wheel Works, Providence, R. I.
Crafts, Arthur A., 125 Summer St., Boston, Mass.
Desmond-Stephan Mfg. Co., Urbana, Ohio.
"Diamo-Carbo" for tool grinding wheels. "Huntington & Sherman" for coarse wheels.
Diamond Saw & Stamping Wks., Buffalo, N. Y.
Trade-mark: "Sterling."
Dickinson, Thomas L., 64 Nassau St., N. Y. City.
Heald Machine Co., 10 New Bond St., Worcester, Mass.
Standard Tool Co., Cleveland, Ohio.
Vitrified Wheel Co., Westfield, Mass.

Drill Holders
Armstrong Bros. Tool Co., 315 N. Francisco Ave., Chicago, Ill.

Drill Speeders
Graham Mfg. Co., Providence, R. I.

Drilling Machine Heads
Covington Multiple Drill Co., Covington, Ky.
Hoefer Mfg. Co., Freeport, Ill.
Nelson-Blanck Mfg. Co., Clay and Dubois St., Detroit, Mich.
Five sizes; capacities No. 0 to 1⅛" drill; weight 10 to 68 lb. Price $50 to $85.
Clamps rigidly to machine, quick adjustment.
Sellew Machine Tool Co., Pawtucket, R. I.

Drilling Machines, Automatic
Baker Bros., Toledo, Ohio.
National Automatic Tool Co., 7th and South N St., Richmond, Ind. Cable: Natco, Richmond.
Five sizes, 2 to 200 spindles, each spindle with or without independent changes of drill speeds.

Drilling Machines, Bench
Ames Co., B. C., Waltham, Mass.
Barnes Co., W. F. & John, 1995 Ruby St., Rockford, Ill.
Clark Electric Co., Inc., Jas., Jr., 521 W. Main St., Louisville, Ky.
Hisey-Wolf Machine Co., Cincinnati, Ohio.
Hoefer Mfg. Co., Freeport, Ill.
Millers Falls Co., Millers Falls, Mass.
Pratt & Whitney Co., Hartford, Conn.
Robinson Tool Works, Waterbury, Conn
Sigourney Tool Co., Hartford, Conn.
U. S. Electrical Tool Co., Cincinnati, Ohio.

Drilling Machines, Electric and Hand
Chicago Pneumatic Tool Co., Chicago, Ill.
Cincinnati Electrical Tool Co., Cincinnati, Ohio.
Clark Electric Co., Inc., Jas., Jr., 521 W. Main St., Louisville, Ky.
Gem Mfg. Co., 3257 Spruce St., Pittsburgh, Pa.
Hisey-Wolf Machine Co., Cincinnati, Ohio.
Ingersoll-Rand Co., 11 Broadway, New York.
Independent Pneumatic Tool Co., Thor Bldg., Chicago, Ill.
Neil & Smith Electric Tool Co., Cincinnati, Ohio.
U. S. Electrical Tool Co., Cincinnati, Ohio.

Drilling Machines, Gang
Barnes Drill Co., 830 Chestnut, Rockford, Ill.
Moline Tool Co., Moline, Ill.
Colburn Mach. Tool Co., Franklin, Penn.
Cincinnati Bickford Tool Co., The, Oakley, Cincinnati, Ohio. Cable: Augustus, Cincinnati.
Seven sizes, ranging from 20" to 42", with from two to six spindles.
Single or individual round or square tables, with or without tapping attachments, cutting lubricant equipment and with an individual cone or right-angle drive or a continuous rear shaft driven by a belt or motor.

Drilling Machines, Heavy Duty
Amalgamated Machinery Corp., 72 W. Adams St., Chicago, Ill.
Baker Bros., Toledo, Ohio.
Four sizes, models 310, 314, 413, 513.
Barnes Drill Co., Inc., 830 Chestnut, Rockford, Ill.
Colburn Machine Tool Co., Franklin, Penn.
Sizes 24"x36" swing, with or without tapping or other attachment, plain or compound table.
Hoefer Mfg. Co., Freeport, Ill.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.

Drilling Machines, Horizontal (See Boring, Drilling and Milling Machines, Horizontal)

Drilling Machines, Multiple Spindle
Barnes Drill Co., Inc., 830 Chestnut, Rockford, Ill.
Baush Machine Tool Co., 604 Wason Ave., Springfield, Mass.
Moline Tool Co., Moline, Ill.
National Automatic Tool Co., 7th and South N St., Richmond, Ind.
Ten sizes of vertical type, ranges from 8" round head with 8 spindles to 20x48" rectangular head with 72 spindles, head feed down or table feed up, with or without power feed to head or table. Independent change of speed in head to each spindle to suit the size of holes being drilled, with neutral positions for all spindles not in use. Machines may be equipped with automatic tapping attachments, lubricating system for work, motor drive, adjustable tables, or box tables; also a complete line of 2-, 3-, 4- and 5-way horizontal and vertical type machines with fixed or adjustable spindles.
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.
Pratt & Whitney Co., Hartford, Conn.
Reed-Prentice Co., Worcester, Mass.
Sellew Machine Tool Co., Pawtucket, R. I.

Drilling Machine, Pneumatic
Independent Pneumatic Tool Co., Thor Bldg., Chicago, Ill.
Ingersoll-Rand Co., 11 Broadway, New York.
"Little David," all sizes, types and gearing combinations for drilling, reaming, tapping, flue rolling, stud seating, etc.

Drilling Machines, Radial
American Tool Works Co., The, Cincinnati, U. S. A. Cable: "Lathe, Cincinnati."
Sizes—Plain, 2, 2½, 3, 3½, 4, 5, 6, 7-ft. arms; full universal, 4, 5, 6, 7 ft. Sensitive radial 3 ft. ball bearing throughout. Sizes 2 to 3½ ft. inclusive equipped with back gears; 4 to 7 inclusive with triple gears. All full universal are triple geared. Four different types of drives for all sizes: Cone drive, geared speed box for belt and motor drive and direct connected variable speed motor drive without speed box.
See our advertisement on pages 14 and 15.
Baush Machine Tool Co., 604 Wason Ave., Springfield, Mass.
Cincinnati Bickford Tool Co., The, Oakley, Cincinnati, Ohio. Cable: Augustus, Cincinnati.
Regular plain type: 6 sizes, ranging from 2½' to 6'. Universal type: 3 sizes, ranging from 4' to 6'. High speed, high power type, with a 5, 6, 7 or 8' arm and base.
Plain and universal radials furnished with a cone, speed box, variable speed motor or motor and speed box drive. The high-speed radial with a speed box, variable speed motor or constant speed motor and speed box drive. All types of plain, universal and high-speed radials can be furnished with cutting lubricant equipment. Plain and high-speed types with air column binder.
Dreses Machine Tool Co., 227-241 W. McMicken Ave., Cincinnati, O. Cable Address: Dreses.
Sizes—Plain 2½ to 7 ft. Half and full universal 4 to 7 ft.
Cone, speed variator (single pulley) and motor drive.
Fosdick Machine Tool Co., Cincinnati, Ohio.
Sizes: High speed manufacturing, 2', 2½', 3'; heavy duty, 3', 3½', 4', 5', 6'. Cone pulley, gear box, constant or variable speed drives. Plain tilting or universal tables.
Gang Co., William E., Cincinnati, Ohio.
Sizes 2½', 3', 3½', 4'.
Harrington, Son & Co., Inc., Ed., Philadelphia, Pa.
Mueller Machine Tool Co., Cincinnati, Ohio.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.
Reed-Prentice Co., Worcester, Mass.
Union Twist Drill Co., Athol, Mass.

Drilling Machines, Sensitive
Henry & Wright Mfg. Co., 760 Windsor St., Hartford, Conn.
One to 8 spindles, 300 models drilling up to 1¼". Weights, 760 lb. to 5,000 lb.
Agents: Hill, Clarke & Co., Boston, New York and Chicago; Chas. A. Strelinger Co., Detroit; W. E. Shipley Mchry. Co., Philadelphia; Brandes Machy. Co., Cleveland, Ohio.
Knight Machinery Co., W. B., 2000 Lucas Ave., St. Louis, Mo.
Leland-Gifford Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Royersford Fdry. & Mach. Co., Royersford, Penn.
Sigourney Tool Co., Hartford, Conn.
Taylor & Fenn Co., The, 54-70 Arch St., Hartford, Conn. 1 to 6 spindles, 7" from centre of spindle to face of column up to ¾" drill. Adjustable cutter distance between spindles. Furnished with either hand or power feed.

Drilling Machines, Turret
National Automatic Tool Co., 7th and South N St., Richmond, Ind.

Drilling Machines, Vertical
Baker Bros., Toledo, Ohio.
Barnes Co., W. F. & John, 1995 Ruby St., Rockford, Ill.
Barnes Drill Co., Inc., 830 Chestnut, Rockford, Ill.
Cincinnati Bickford Tool Co., The, Oakley, Cincinnati, Ohio. Cable: Augustus, Cincinnati.
Regular type: 7 sizes and 88 styles, ranging from 21" to 42". High speed type: 7 sizes and 52 styles ranging from 20" to 42".
Furnished with or without a tapping attachment, with a cone, speed box or right-angle drive, with a motor and speed-box drive, with a belted motor, geared motor or variable speed motor drive with or without a cutting lubricant equipment and with a round, square or compound table.
Colburn Machine Tool Co., Franklin, Penn.
Garvin Mach. Co., Spring and Varick St., N. Y. C.
Greenfield Tap & Die Corp., Greenfield, Mass.
Harrington, Son & Co., Inc., Ed., Philadelphia, Pa.
Hoefer Mfg. Co., Freeport, Ill.
Types and sizes up to 36" gear tappers, compound tables, machines set in gang to order.
Knight Machinery Co., W. B., 2000 Lucas Ave., St. Louis, Mo.
Leland-Gifford Co., Worcester, Mass.
Moline Tool Co., Moline, Ill.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.
Reed-Prentice Co., Worcester, Mass.
Royersford Fdry. & Mach. Co., Royersford, Penn.
10", 14", 20" from smallest hole to 1¼".
Sellers & Co., Inc., Wm., Philadelphia, Penn.
Sigourney Tool Co., Hartford, Conn.

Drills, Center
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
National Twist Drill & Tool Co., Detroit, Mich.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Providence, R. I.
Standard Tool Co., Cleveland, Ohio.
Union Twist Drill Co., Athol, Mass.

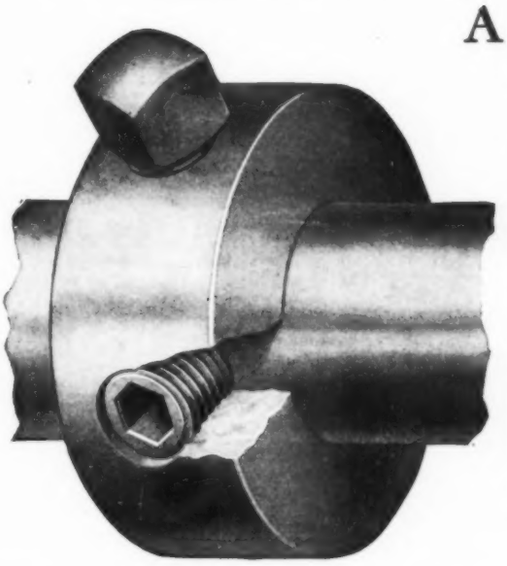
Drills, Ratchet
Cleveland Twist Drill Co., Cleveland, Ohio.
Pratt & Whitney Co., Hartford, Conn.
Union Twist Drill Co., Athol, Mass.
Whitman & Barnes Mfg. Co., Akron, Ohio.

Drills, Square Hole
Radical Boring Head Corp., 90 West St., N. Y. C.

Drills, Twist and Flat
Celfor Tool Co., Buchanan, Mich.
Cleveland Twist Drill Co., E. 49th St. and Lakeside Ave., Cleveland, Ohio. Branches: New York, 30 Reade St.; Chicago, 9 N. Jefferson St.
Sizes No. 80 to 4" diameter (stock).
Agents: Alfred Herbert, Ltd., Coventry, England; V. Lowener, Copenhagen, Denmark; R. D'Aulignac, Barcelona, Spain; Becker & Co., Kobe, Japan; Fenwick Freres & Co., Paris, France; E. Sonnenthal, Jr., Berlin, Germany; S. G. Weinberg, Petrograd, Russia; Ignacz Szekely, Budapest, Hungary; V. Lowener, Stockholm, Sweden; E. Sonnenthal, Jr., Vienna, Austria; A. Asher Smith, Sidney, Australia; V. Lowener, Christiania, Norway.

Which is Stronger?

A Stamped or Milled Screw?



Send for free samples of H. S. & Co. Hollow Set Screws and make your own tests.

The H. S. & Co. Hollow Set Screws have several marked advantages, notably—

1st. Are tougher and "bite" better and therefore hold better.
2nd. Being made from sheet metal, they outlast and out-test any screw milled from solid bar.
3rd. Sides are absolutely uniform, insuring perfect fit of wrench.
4th. Holes are deeper, permitting wrench to come closer to point of screw, thereby insuring full tightening power.

Proper tests prove beyond a doubt that stamped screws are stronger and tougher than those milled from solid bar, owing to the position of the fibres of the steel. Well-known proof of this is found in the comparative values of semi-finished nuts, those milled from solid rod not being as strong as the stamped goods.

Send today for Special Circular No. 45.

Hammacher, Schlemmer & Company

HARDWARE, TOOLS and SUPPLIES

New York, Since 1848 **4th Avenue and 13th Street**

Large Size Micrometers

Nowadays every workman's tool-chest has a one-inch micrometer. But what about dimensions above one inch? Do you supply micrometers for these, or do your shop men still have to use antiquated calipers?

Slocomb Micrometers in the Larger Sizes

are just as efficient as the now nearly universally used one-inch size. If you can spoil work that is **under** one inch because of poor calipering, isn't it more serious to spoil work over one inch?
The Slocomb Set No. 20 shown here consists of 12 mikes ranging for a 1" size up to 12".
The rack is cast iron nicely black enameled. The wood slats are of oak, and buttons are of rubber.
There is not a shop, however large or small, that can afford to be without a Slocomb Set No. 20.

Catalog 14-A on request.

J. T. Slocomb Co.

Providence, R. I., U. S. A.

Representatives in England, Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. Germany and Austria-Hungary, F. G. Kretschmer & Co., Frankfort a. Main; Chas. Cirita, Milan.

SLOCOMB MICROMETERS ARE ACCURATE

Registered Trade Mark

Detroit Twist Drill Co., 644 Fort St., Detroit.
Hammacher, Schlemmer & Co., 13th St. and 4th Ave., New York City.
McKenna Bros. Brass Co., Pittsburgh, Penn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
National Twist Drill & Tool Co., Detroit, Mich.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, Ohio.
Union Twist Drill Co., Athol, Mass.
Whitman & Barnes Mfg. Co., Akron, Ohio.

Dynamometers
General Electric Co., Schenectady, N. Y.
Sprague Electric Works, 527 W. 34th St., N. Y. C.

Electrical Instruments
Brown Instrument Co., Philadelphia, Penn.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Penn.

Electrical Supplies
D & W Fuse Co., Providence, R. I.
General Electric Co., Schenectady, N. Y.
Johns-Manville Co., H. W., 41st St. and Madison Ave., New York City.
Sprague Electric Works, 527 W. 34th St., N. Y. C.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Penn

Elevating Trucks (See Trucks)

Elevators
Link-Belt Co., 39th St. and Stewart Ave., Chicago, Ill. Philadelphia and Indianapolis.

Emery Wheels (See Grinding Wheels)

Enamels, Machinery
Felton, Sibley & Co., Inc., 136 N. 4th St., Phila.
Moller & Schumann Co., 8 Gerry St., Brooklyn,

Engineers, Mechanical and Electrical
Harris Engineering Co., H. E., Bridgeport, Conn.
Taft-Peirce Mfg. Co., Woonsocket, R. I.

Engines, Steam
American Blower Co., 1400 Russell St., Detroit.
Nazel Engineering & Machine Works, 4041 N. 5th St., Philadelphia, Penn.

Engraving Machinery
Gorton Machine Co., Geo., Racine, Wis.

Expanders, Tube
Watson-Stillman Co., 42 Church St., N. Y. City.

Eyeglasses, Safety (See Goggles, Safety)

Fans, Electric
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., Schenectady, N. Y.
Sprague Electric Works, 527 W. 34th St., N. Y. C.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Penn.

Fans, Exhaust
American Blower Co., 1400 Russell St., Detroit.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Penn.

File Handles
Doane Mfg. Co., Alls Station, Boston, Mass.
Nicholson File Co., Providence, R. I. Cable: Nicholson, Providence.
Western Tool & Mfg. Co., Springfield, Ohio.

Files and Rasps
Barnett, G. & H., Philadelphia, Penn.
Disston & Sons, Inc., Henry, Philadelphia, Penn.
Hammacher, Schlemmer & Co., 13th St. and 4th Ave., New York City.
Montgomery & Co., 108 Fulton St., N. Y. City.
Nicholson File Co., Providence, R. I. Cable: Nicholson, Providence.
The following brands: Nicholson, Kearney & Foot, Eagle, McClellan, J. Barton Smith, Arcade, American, Great Western, Superior rasps, Swiss pattern, extra (X + F), fine; jewelers, extra (X + F), fine.
Simonds Mfg. Co., Fitchburg, Mass. New York, Chicago, Montreal, Memphis, New Orleans, San Francisco, Portland, Seattle, Vancouver, St. Johns.

Filing Machines
Ames Co., B. C., Waltham, Mass.
Detrick & Harvey Mach. Co., Baltimore, Md.
Rearwin, W. D., Mill Ave., N. W., Grand Rapids, Mich.
Length of stroke adjustable from 0 to 7". Irregular shape files can be used in this machine. Weight 375 lb.

Filler, Iron (See Cements, Iron)

Filters, Oil
Oil & Waste Saving Mach. Co., Real Estate Trust Bldg., Philadelphia, Penn.
Richardson-Phenix Co., 119 Reservoir Ave., Milwaukee, Wis.
Oil filters and automatic systems for circulating, filtering and sterilizing cutting oils and compounds.

Fittings, Hydraulic
Watson-Stillman Co., 42 Church St., N. Y. City.

Flexible Shafts
Errington, F. A., 39 Cortlandt St., N. Y. City.
Gem Mfg. Co., 3257 Spruce St., Pittsburgh, Pa.
½ to 1⅜" core.
Stow Mfg. Co., Binghamton, N. Y. 85 Queen Victoria St., London, E. C., England.

Forging Machinery
Billings & Spencer Co., Hartford, Conn.
National Machinery Co., Tiffin, Ohio.

Forgings, Drop
Billings & Spencer Co., Hartford, Conn.
Bliss & Co., E. W., 1 Adams St., Brooklyn, N. Y.
Camden Forge Co., Mt. Ephraim Ave., Camden, N. J.
Moore Drop Forging Co., 333 Birnie Ave., Springfield, Mass.
Page-Storms Drop Forge Co., Chicopee, Mass.
Whitman & Barnes Mfg. Co., Akron, Ohio.
Williams Co., J. H., 35 Richards St., Brooklyn.

Forgings, Hammer
Billings & Spencer Co., Hartford, Conn.
Camden Forge Co., Mt. Ephraim Ave., Camden, N. J.
Smooth forged, rough turned or finished complete.
Halcomb Steel Co., Syracuse, N. Y.
Hobson, Houghton & Co., 83 Beekman, N. Y. C.
Moore Drop Forging Co., 333 Birnie Ave., Springfield, Mass.
Page-Storms Drop Forge Co., Chicopee, Mass.
Williams Co., J. H., 35 Richards St., Brooklyn.

Foundry Supplies
Dixon Crucible Co., Joseph, Jersey City, N. J.
Paxson Co., J. W., 1021 Delaware Ave., Phila.

Fountains, Drinking
Manufacturing Equipment & Engineering Co., 209 Washington St., Boston, Mass.
Sanitary Fountain & Specialty Co., 176 Federal St., Boston, Mass.

Furnaces, Heat Treating, Oil and Gas
American Gas Furnace Co., 24 John St., N. Y. C.
General Electric Co., Schenectady, N. Y.
Gilbert & Barker Mfg. Co., 11 Union St., Springfield, Mass.
Rockwell Co., W. S., 50 Church St., N. Y. City.

Furnaces, Heat Treating Electric
Brown Instrument Co. Philadelphia, Penn.
General Electric Co., Schenectady, N. Y.

Furniture, Machine Shop
Garwood Bronze & Iron Wks., Garwood, N. J.
Manufacturing Equipment & Engineering Co., 209 Washington St., Boston, Mass.
New Britain Machine Co., 20 Chestnut St., New Britain, Conn.
Bench legs and drawers; portable work stands; vise stands; vises; bar stock racks; tool storage racks; blacksmith racks; lathe racks; revolving screw racks; screw machine racks; shelving; scraping tables; stools; lathe pans; permanent ladders; oil and soda water feeders.
Western Tool & Mfg. Co., Springfield, Ohio.

Gages, Dial
Ames Co., B. C., Waltham, Mass.
Randall & Stickney, Waltham, Mass.
Starrett Co., L. S., Athol, Mass.

Gages, Measuring
Cleveland Twist Drill Co., Cleveland, Ohio.
Greenfield Tap & Die Corp., Greenfield, Mass.
Gronkvist Drill Chuck Co., 18 Morris St., Jersey City, N. J.
"Johansson" combination standard gages, furnished in systems to give all sizes in .00005", .0001", .0005", .001", 64ths, 32nds, 16ths and mm. Accuracy .00001" according to combination. "Johansson" adjustable limit snap gages, adjustable for wear, different sizes and changing limits. Made with insulated grip. Capacity of smallest size is 0-¼"; capacity of largest size 11"-12".
"Johansson" tolerance plug gages, all sizes up to 8". Reversible, interchangeable measuring members. Light weight.
Harris Engineering Co., H. E., Bridgeport, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Reed & Prince Mfg. Co., Worcester, Mass.
Slocomb Co., J. T., Providence, R. I.
Southwark Fdry. & Mach. Co., Philadelphia, Pa.
Starrett Co., L. S., Athol, Mass.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Walker Co., O. S., Worcester, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Williams Co., J. H., 35 Richards St., Brooklyn.

Gages, Recording
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Penn.
Starrett Co., L. S., Athol, Mass.

Gas, Compressed
Davis-Bournonville Co., Jersey City, N. J.
International Oxygen Co., 115 Bway., New York.
Linde Air Products Co., 42nd St. Bldg., N. Y. C.
Oxweld Acetylene Co., Chicago, Ill.

Gaskets
Graton & Knight Mfg. Co., Worcester, Mass.

Gear Cutting Machines
Adams Co., 1902 Bridge Ave., Dubuque, Iowa.
Barber-Colman Co., Rockford, Ill.
Becker Milling Machine Co., Hyde Park, Mass.
Bilgram Machine Works, 1233 Spring Garden St., Philadelphia, Penn.
Boston Gear Works Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
For spur and bevel gears. Three sizes. Capacities range from 12" diameter, 8" face to 24" diameter, 6" face. Largest machine handles gears up to 3 diametral pitch in cast iron and 4 diametral pitch in steel.
For spur gears only. 5 sizes. Capacities range from 24" diameter, 8" face to 72" diameter, 13" face. All have powerful single pulley constant feed drive. Largest machine handles gears up to 1¾ diametral pitch in cast iron, 2 diametral pitch in steel.
For branches and agents see our advertisement.
Cincinnati Shaper Co., Cincinnati, Ohio.
Fellows Gear Shaper Co., The, Springfield, Vt.
No. 6—capacity for spur gears 35" pitch diameter, 5" face, 4 diametrical pitch; for internal gears 26" pitch diameter, 3" face, 4 pitch. No. 65—capacity 35" pitch diameter, 5" face, 6 diametral pitch. Price of No. 6, $1,575; price of No. 65, $1,850. Weight of No. 6, 3,855 lb.; weight of No. 65, 4,116 lb. No. 6 machine cuts spurs and internals only and uses a cutter of the generating type. No. 65 is a machine for helicals only and uses a cutter of the generating type.
Agents: Ph. Bonvillain & E. Ronceray, Paris; M. Koyemann, 112 Charlottenstrasse, Dusseldorf; White, Child & Beney, Vienna, Austria; Henry Kelley & Co., 26 Pall Mall, Manchester, Eng.
Flather Mfg. Co., E. J., Nashua, N. H.
Garvin Mach. Co., Spring and Varick St., N. Y. C.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Disc cutter type for spur gears. Horizontal cutting type. Sizes—36", 60", 72". Vertical cutting type. Sizes—36", 60", 120".
For spur and bevel gears. Horizontal cutting type 62" and 74". Vertical cutting type 24" and 48".
Hobbing type for spur, helical and worm gears. Sizes: 12", 18", 36", 72".
Multiple spindle type for roughing out spur and bevel gears. 24" for cutting 2 gears at one time up to 11" dia. or 3 gears at one time up to 5½" dia. 48" for cutting 2 gears at one time up to 18" dia. or 3 gears at one time up to 9" dia.
Harrington, Son & Co., Inc., Ed., Philadelphia.
Lees, Bradner & Co., Cleveland, Ohio.
M.-C. Mfg. Co., 28 Congress St., Newark, N. J.
Newark Gear Cutting Machine Co., Newark, N. J.
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.
Prentiss Tool & Supply Co., Singer Bldg., N. Y. C.
Strong, Carlisle, Hammond Co., Cleveland, Ohio.
Waltham Mach. Works, High St., Waltham, Mass.
Whiton Mach. Co., D. E., New London, Conn.

Gear Tempering Machinery
Gleason Works, Rochester, N. Y.

Gear Testing Machinery
Adams Co., 1902 Bridge St., Dubuque, Iowa.
Gleason Works, Rochester, N. Y.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Union Twist Drill Co., Athol, Mass.

Gears, Cast
Brown Co., A. & F., 79 Barclay St., N. Y. City.
Citroen Gear Co., Paris, France.
Cleveland Worm & Gear Co., Cleveland, Ohio.
Doehler Die Casting Co., Court and Ninth St. Brooklyn, N. Y.
Franklin Mfg. Co., 400 S. Geddes St., Syracuse.
Grant Gear Works, Inc., 151 Pearl St., Boston.
Horsburgh & Scott Co., Cleveland, Ohio.
Meisel Press Mfg. Co., 946 Dor. Ave., Boston.
Philadelphia Gear Works, Vine St. and Reading R.R., Philadelphia, Penn.
Van Dorn & Dutton Co., Cleveland, O. New York, Baltimore, Atlanta, Denver, Salt Lake City and San Francisco.

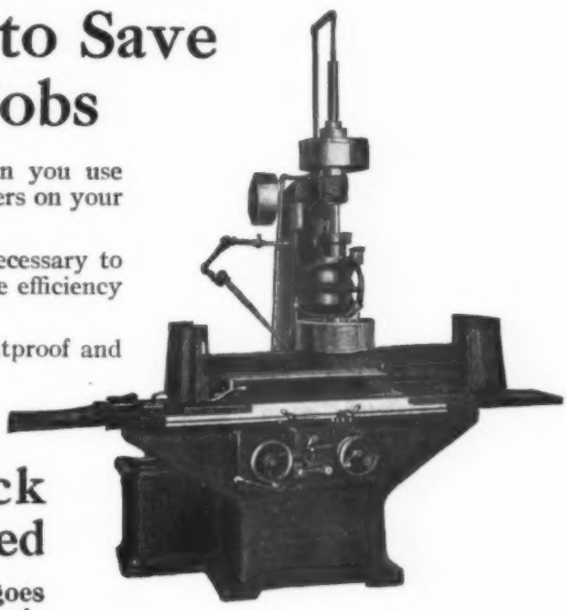
Gears, Cut and Worm
Adams Co., 1902 Bridge Ave., Dubuque, Iowa.
Albaugh-Dover Co., Marshall Blvd. and 21st, Chicago, Ill.
Bilgram Machine Works, 1233 Spring Garden St., Phil delphia, Penn.
Boston Gear Works, Norfolk Downs, Mass.
Brown Co., A. & F., 79 Barclay St., N. Y. City.
Cambridge Machine Co., Cambridge, Ohio.
Chicago (Ill.) Rawhide Mfg. Co., 1301 Elston Ave.
Cincinnati (O.) Gear Co., 1825 Reading Road.
Citroen Gear Co., Paris, France.
Cleveland Worm & Gear Co., The, Cleveland, O. Cable: Gearing.
Worm gear speed reductions. Straight type worm. All worms ground after hardening to correct distortion. Worm reduction cases supplied complete.
Earle Gear & Machine Co., 101 E. Wyoming Ave., Philadelphia, Penn.
Farrel Foundry & Machine Co., Ansonia, Conn.
Fawcus Machine Co., Pittsburgh, Penn.
Flather Mfg. Co., E. F., Nashua, N. H.
Foote Bros. Gear & Mach. Co., 210 N. Carpenter St., Chicago, Ill.
Cut gears all kinds, spur and worm gear speed reducers.
Garvin Mach. Co., Spring and Varick St., N. Y. C.
General Electric Co., Schenectady, N. Y.

The "D & W" Way to Save Time Between Jobs

You'll realize the full benefit of electricity when you use "D & W" Magnetic Chucks in place of the workholders on your shapers, planers, grinders and special machines.

There are no expensive additional attachments necessary to get efficiency from "D & W" Magnetic Chucks. The efficiency is in the Chucks themselves.

They can be used anywhere because they are heatproof and waterproof.



Magnetic Chuck Service Explained

Our new catalog No. 10-A goes into every phase of magnetic chucks and tells you what you can expect and why. Get posted —write today.

D & W FUSE COMPANY
Providence, R. I.

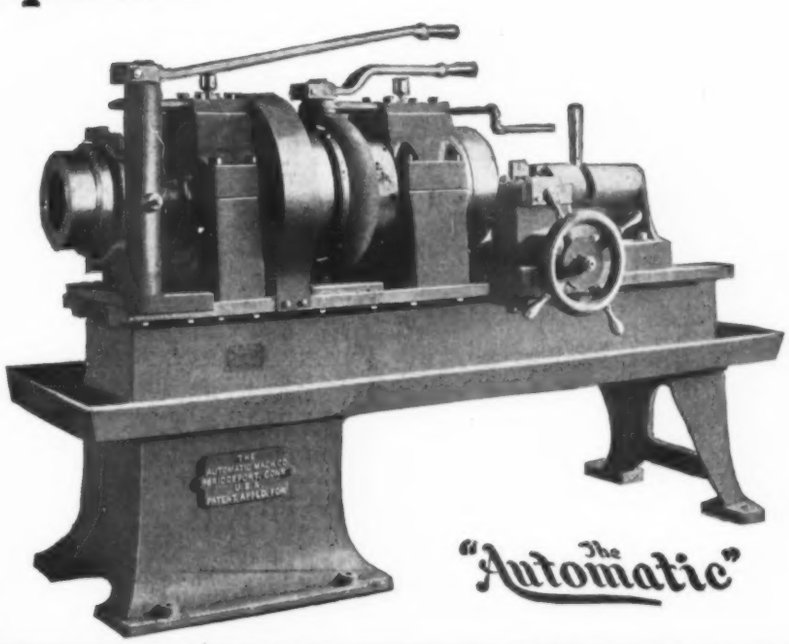
This is the Machine for Cutting the Bands Used on Shrapnel—

THE demand for a suitable machine for cutting to lengths copper tubing used for bands on shrapnel and high explosive shells induced us to design the machine here illustrated. We also find it very useful for cutting steel tubing for roller bearing or similar work.

The actual time necessary for one cycle of operation, on the small machine, i.e., to feed, chuck and cut off 3 to 6 bands, is less than one minute.

There are three sizes: $3\frac{3}{4}''$, $6\frac{3}{4}''$ $11''$.

Write for particulars.



Automatic Machine Co.
Bridgeport, Conn.

"The Automatic"

Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Inc., 151 Pearl St., Boston,
Horsburgh & Scott Co., Cleveland, Ohio.
Link-Belt Co., 39th St. and Stewart Ave., Chicago, Ill. Philadelphia and Indianapolis.
M.-C. Mfg. Co., 28 Congress St., Newark, N. J.
Meisel Press Mfg. Co., 946 Dor. Ave., Boston.
Newark Gear Cutting Machine Co., Newark, N. J.
New England Gear Wks., 100 Purchase St., Boston.
New Process Gear Corporation, Syracuse, N. Y.
Spur, worm, spiral, bevel and internal gears of any metal. Spur and bevel gears and pinions of rawhide and vulcanized fiber.
Spur gears up to 60 in. in diameter, plane bevels up to 50 in., and generated bevels of from 3 to 12 pitch up to 18 in. in diameter.
New Process noiseless gears and pinions. Spurs and bevels up to 36 in. diameter.
Furnished as all rawhide blanks, all rawhide with teeth cut or complete with any desired metal hubs, collars, shrouds, flanges or bushings.
Cutting, generating and finishing tools and carbonizing, hardening and heat-treating facilities to meet requirements of economical quantity and quality production. Service includes designing (when necessary), pattern work, furnishing castings, forgings or bar stocks and complete finishing.
Nuttall Co., R. D., Pittsburgh, Penn.
Philadelphia Gear Works, Vine St. and Reading R.R., Philadelphia, Penn.
Sawyer Gear Works, 5121 St. Clair, Cleveland, O.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Van Dorn & Dutton Co., Cleveland, O. New York, Baltimore, Atlanta, Denver, Salt Lake City and San Francisco.

Gears, Herringbone
Citroen Gear Co., Paris, France.
Earle Gear & Machine Co., 101 E. Wyoming Ave., Philadelphia, Penn.
Fawcus Machine Co., Pittsburgh, Penn.
Meisel Press Mfg. Co., 946 Dor. Ave., Boston.

Gears, Rawhide (See Gears, Cut and Worm)

Generators, Electric
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., Schenectady, N. J.
Reliance Electric & Engineering Co., 1044 Ivanhoe Rd., Cleveland, Ohio.
Sprague Electric Works, 527 W. 34th St., N. Y. C.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Penn.

Graphite
Dixon Crucible Co., Joseph, Jersey City, N. J.
Felton, Sibley & Co., Inc., 136 N. 4th St., Phila.

Greases, Lubricating
Houghton & Co., E. F., 240 W. Somerset St., Philadelphia, Penn.
Oil City Oil & Gerase Co., Oil City, Penn.
Texas Company, Dept. A, 17 Battery Pl., N. Y. C.

Grinding Machines, Ball Bearing Race
Landis Tool Co., Waynesboro, Penn. Cable: Landis, Waynesboro.
Rivett Lathe & Grinder Co., Brighton, Boston, Mass. Cable: Edrivett.
One size. Ball races up to 5" dia.
No. 11 grinder with automatic oscillating motion and cross feed.
See our advertisement on inside of back cover.
Van Norman Machine Tool Co., Wilbraham Ave., Springfield, Mass.

Grinding Machines, Bench
Athol Machine Co., Athol, Mass.
Blount Co., J. G., Woodland St., Everett, Mass.
Clark Electric Co., Inc., Jas., Jr., 521 W. Main St., Louisville, Ky.
Forbes & Myers, 172 Union St., Worcester, Mass.
Hisey-Wolf Machine Co., Cincinnati, Ohio.
Safety Emery Wheel Co., Larch St., Springfield, O.
Union Twist Drill Co., Athol, Mass.
U. S. Electrical Tool Co., Cincinnati, Ohio.
Van Norman Machine Tool Co., Wilbraham Ave., Springfield, Mass.
Walker Co., O. S., Worcester, Mass.

Grinding Machines, Center
Cincinnati Electrical Tool Co., Cincinnati, Ohio.
Gem Mfg. Co., 3257 Spruce St., Pittsburgh, Pa.
Greenfield Machine Co., Greenfield, Mass.
Hisey-Wolf Machine Co., Cincinnati, Ohio.
Stow Mfg. Co., Binghamton, N. Y.
Wilmarth & Morman Co., 1187 Monroe Ave., Grand Rapids, Mich.

Grinding Machines, Chucking
Bryant Chucking Grinder Co., Springfield, Vt.
Heald Machine Co., 10 New Bond St., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rivett Lathe & Grinder Co., Brighton, Boston.

Grinding Machines, Cutter and Reamer
Cincinnati Milling Machine Co., Oakley, Cincinnati, Ohio.
Garvin Mach. Co., Spring and Varick St., N. Y. C.
Gould & Eberhardt, Newark, N. J.
For single or gang cutters, any pitch or size to 10" dia.
Greenfield Machine Co., Greenfield, Mass.
Swings 6¾"x21" on centers or 11" on holder; 12 attachments for tool making and sharpening. Weight 650 lb.
Heald Machine Co., 10 New Bond St., Worcester, Mass.
Ingersoll Milling Machine Co., The, Rockford, Ill.
Grinds cutters only; 4¼ to 24 inches, also to 36 inches. Catalogue No. 35 for description.
Advertisement page 8.
LeBlond Machine Tool Co., R. K., Cincinnati, O.
Leland-Gifford Co., Worcester, Mass.
Norton Grinding Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Union Twist Drill Co., Athol, Mass.
U. S. Electrical Tool Co., Cincinnati, Ohio.
Walker Co., O. S., Worcester, Mass.
Wells & Son Co., F. E., Greenfield, Mass.
Wilmarth & Morman Co., 1187 Monroe Ave., Grand Rapids, Mich.

Grinding Machines, Cylindrical
Bryant Chucking Grinder Co., Springfield, Vt.
Greenfield Machine Co., Greenfield, Mass.
For work under 12"x2½" in diameter.
Heald Machine Co., 10 New Bond St., Worcester, Mass.
Hisey-Wolf Machine Co., Cincinnati, Ohio.
Landis Tool Co., Waynesboro, Penn. Cable: Landis, Waynesboro.
Universal and plain. Sizes, universal No. 1, No. 1½, No. 2, No. 3, No. 4. Nos. 2, 3 and 4 are also built with 16" swing, and are used for finishing tools and a variety of straight or taper parts, both external and internal. Attachments, such as magnetic chuck, gear-cutter attachment, side mill grinding attachment, etc.
Plain—Sizes 6", 10", 12", 20", 30", 40" swings in standard lengths. These manufacturing machines are intended for finishing straight and taper spindles, shafts, rolls, tubing and all other work within their range which can be revolved on dead centers.
Plain machines also built with gap in the bed to suit the location of the projection on the work, 16" and 20" swing. Especially valuable for grinding locomotive piston rods.
Leland-Gifford Co., Worcester, Mass.
Modern Tool Co., 4th and French St., Erie, Penn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Norton Grinding Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Van Norman Machine Tool Co., Wilbraham Ave., Springfield, Mass.
Walker Co., O. S., Worcester, Mass.

Grinding Machines, Die
Bignall & Keeler Machine Co., Edwardsville, Ill. Cable: Bikeeler.
Geometic Tool Co., New Haven, Conn. 545 W. Washington Blvd., Chicago. Cable: Metric.
Geometric chaser or die grinder for grinding any make of thread chaser, whether standard or special. Also for ordinary tool grinding.
Landis Machine Co., Waynesboro, Penn.
Murchey Mach. & Tool Co., 64 Porter St., Detroit.
National Machinery Co., Tiffin, Ohio.

Grinding Machines, Disk
Landis Machine Co., Waynesboro, Penn.
Rowbottom Machine Co., Waterbury, Conn.

Grinding Machines, Drill
Heald Machine Co., 10 New Bond St., Worcester, Mass.
Hisey-Wolf Machine Co., Cincinnati, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Safety Emery Wheel Co., Larch St., Springfield, O.
Sellers & Co., Inc., Wm., Philadelphia, Penn.
Standard Tool Co., Cleveland, Ohio.
U. S. Electrical Tool Co., Cincinnati, Ohio.
Wells & Son Co., F. E., Greenfield, Mass.
Wilmarth & Morman Co., 1187 Monroe Ave., Grand Rapids, Mich.

Grinding Machines, Internal
Bryant Chucking Grinder Co., Springfield, Vt.
Garvin Mach. Co., Spring and Varick St., N. Y. C.
Greenfield Machine Co., Greenfield, Mass.
Heald Machine Co., 10 New Bond St., Worcester, Mass.
Hisey-Wolf Machine Co., Cincinnati, Ohio.
Landis Tool Co., Waynesboro, Penn. Cable: Landis, Waynesboro.
For straight and taper internal grinding fixtures. Will grind holes ¼" diam. or larger and up to 12" long.
Leland-Gifford Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rivett Lathe & Grinder Co., Brighton, Boston, Mass. Cable: Edrivett.
Two sizes.
No. 3 grinder with power feed, No. 8 hand feed.
U. S. Electrical Tool Co., Cincinnati, Ohio.
Van Norman Machine Tool Co., Wilbraham Ave., Springfield, Mass.
Walker Co., O. S., Worcester, Mass.

Grinding Machines, Portable
Armstrong-Blum Mfg. Co.
Chicago Pneumatic Tool Co., Chicago, Ill.
Clark Electric Co., Inc., Jas., Jr., 521 W. Main St., Louisville, Ky.
Gem Mfg. Co., 3257 Spruce St., Pittsburgh, Penn.
Independent Pneumatic Tool Co., Thor Bldg., Chicago, Ill.
Ingersoll-Rand Co., 11 Broadway, New York.
"Little David" pneumatic grinders.
Nell & Smith Electric Tool Co., Cincinnati, Ohio.
Stow Mfg. Co., Binghamton, N. Y.
U. S. Electrical Tool Co., Cincinnati, Ohio.

Grinding Machines, Snagging
Forbes & Myers, 172 Union St., Worcester, Mass.
La Salle Machine & Tool Co., La Salle, Ill.
Walker Co., O. S., Worcester, Mass.
Wells & Son Co., F. E., Greenfield, Mass.

Grinding Machines, Surface
Blanchard Machine Co., The, 64 State St., Cambridge, Mass.
One size; range 30" diameter by 12" high either 26" or 30" magnetic chuck; made with countershaft, belted motor and direct motor drive; approximate weight, 8,500 lb.
For finishing flat surfaces on castings, forgings, stampings or pieces of bar stock; either hardened or soft; rough or machined.
Domestic Agents: Prentiss Tool & Supply Co., Motch & Merryweather Machinery Co., Marshall & Huschart Machinery Co., W. E. Shipley Machinery Co., Kemp Machinery Co., Robinson, Cary & Sands Co., Pacific Tool & Supply Co. Canada: Williams & Wilson, Ltd., A. R. Williams Machinery Co., Ltd. Great Britain: C. W. Burton, Griffiths & Co.
Detrick & Harvey Mach. Co., Baltimore, Md.
Diamond Machine Co., Providence, R. I.
Garvin Mach. Co., Spring and Varick St., N. Y. C.
Heald Machine Co., 10 New Bond St., Worcester, Mass.
La Salle Machine & Tool Co., La Salle, Ill.
Leland-Gifford Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rowbottom Machine Co., The, Waterbury, Conn.
Safety Emery Wheel Co., Larch St., Springfield, O.
Walker Co., O. S., Worcester, Mass.
Wilmarth & Morman Co., 1187 Monroe Ave., Grand Rapids, Mich.

Grinding Machines, Tool
Barnes Co., W. F. & John, 1995 Ruby St., Rockford, Ill.
Blake & Johnson Co., The, Waterbury, Conn.
Blount Co., J. G., Woodland St., Everett, Mass.
Cincinnati Milling Machine Co., Oakley, Cincinnati, Ohio.
Forbes & Myers, 172 Union St., Worcester, Mass.
Greenfield Machine Co., Greenfield, Mass.
Universal tool and cutter grinder for tool making and sharpening.
Landis Machine Co., Waynesboro, Penn.
La Salle Machine & Tool Co., La Salle, Ill.
LeBlond Machine Tool Co., R. K., Cincinnati, O.
Leland-Gifford Co., Worcester, Mass.
Modern Tool Co., 4th and French St., Erie, Penn.
Norton Grinding Co., Worcester, Mass.
Oesterlein Machine Co., Cincinnati, Ohio.
Royersford Fdry. & Mach. Co., Royersford, Penn.
Five sizes, for wheels 6" to 20", double head.
Safety Emery Wheel Co., Larch St., Springfield, O.
Standard Tool Co., Cleveland, Ohio.
Taylor & Fenn Co., The, Hartford, Conn.
Union Twist Drill Co., Athol, Mass.
U. S. Electrical Tool Co., Cincinnati, Ohio.
Vitrified Wheel Co., Westfield, Mass.
Walker Co., O. S., Worcester, Mass.
Wells & Son Co., F. E., Greenfield, Mass.
Wilmarth & Morman Co., 1187 Monroe Ave., Grand Rapids, Mich.

Grinding Machines, Cutter and Reamer
Brown & Sharpe Mfg. Co., Providence, R. I.
Two sizes. Take cutters to 6" diameter, 6" long. Saws to 24" diameter.
Oesterlein Machine Co., Cincinnati, Ohio.

Grinding Machines, Cylindrical
Brown & Sharpe Mfg. Co., Providence, R. I.
4 sizes. Capacities range 10" diameter x 21" long to 12" diameter x 60" long. Catalog or descriptive circular on request.
For branches and agents see our advertisement.

Grinding Machines, Internal
Brown & Sharpe Mfg. Co., Providence, R. I.
5 sizes. Capacities range from 6" diameter, 20" long to 10" diameter, 72" long.
Catalog or descriptive circulars on request.
For branches and agents see our advertisement.

Grinding Machines, Surface
Brown & Sharpe Mfg. Co., Providence, R. I.
One size; grinds work to 18" long, 6" wide and 9½" high. Work can be clamped on table or held on magnetic chuck. Attachments can be furnished to adapt the machine to wet grinding.
For branches and agents see our advertisement.

Grinding Machine, Tool
Brown & Sharpe Mfg. Co., Providence, R. I.
Two sizes. Can be used for a variety of tool grinding, and in addition are adapted to cylindrical grinding, both straight and taper, and with the aid of attachments internal and surface grinding can be accomplished.

Grinding Wheels
American Emery Wheel Wks., Providence, R. I.
Corundum wheels, carbolite wheels, emery wheels. All sizes, shapes, grits, grades.
Carborundum Co., Niagara Falls, N. Y. N. Y. City, Chicago, Boston, Phila., Cleveland, Cincinnati, Pittsburgh, Milwaukee, Grand Rapids, Manchester, Eng.; Dusseldorf, Germany.
Carborundum and Aloxite grinding wheels.
Dickinson, Thomas L., 64 Nassau St., N. Y. City.
Norton Co., Worcester, Mass. New York, 151 Chambers St.; Chicago, 11 N. Jefferson St.;

IRON AND STEEL FORGINGS

Steel *versus* Iron

We have always retained our facilities for manufacturing Iron forgings for the reason that the bitter war of Steel against Iron is by no means settled.

We are neutral and will not even discuss the relative merits of the two sides as we have friends in both camps.

If you believe that Iron is the better metal to withstand shock, we will supply you with the best grade of Iron. If you lean toward steel for the same service, we have an ample stock of varying carbons to suit your requirements.

We do not attempt to make the smaller sizes of bar Iron which are readily rolled. Four inches square and up fall within our capacity.

Camden Forge Co., Mount Ephraim Ave., Camden, N.J.

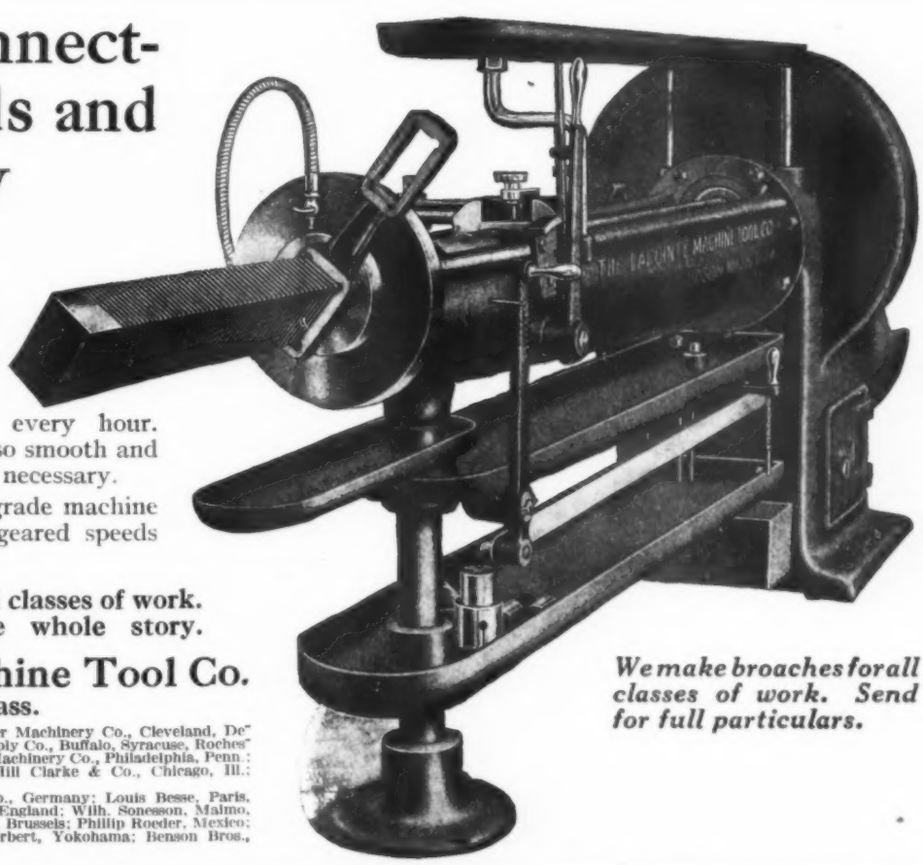
CAMDEN FORGE COMPANY

Broach Connecting Rod Ends and Save Money

Unless you are already using a No. 4 Lapointe Broaching Machine, we can save you time and money on the finishing of connecting rod ends. One Lapointe user regularly broaches 25 drop-forged steel rod ends measuring 6x4x2″ every hour. And the surfaces produced are so smooth and true that no other machining is necessary.

The No. 4 Lapointe is a high-grade machine with a single belt drive, two-geared speeds and ball bearings throughout.

We make broaches for all classes of work. Catalog "C" tells the whole story.



We make broaches for all classes of work. Send for full particulars.

The Lapointe Machine Tool Co.
Hudson, Mass.

DOMESTIC AGENTS: Motch & Merryweather Machinery Co., Cleveland, Detroit, Cincinnati, Pittsburgh; Prentiss Tool & Supply Co., Buffalo, Syracuse, Rochester, New York, Scranton, Boston; W. E. Shipley Machinery Co., Philadelphia, Penn.; Vonnegut Machinery Co., Indianapolis, Ind.; Hill Clarke & Co., Chicago, Ill.; Aumen Machinery Co., Baltimore, Md.
FOREIGN AGENTS: F. G. Kretschmer & Co., Germany; Louis Besse, Paris, France; C. W. Burton, Griffiths & Co., London, England; Wilh. Sonesson, Malmo, Sweden; A. H. Schutte, Petrograd; Stokvis & Fils, Brussels; Phillip Roeder, Mexico; D. Drury, Johannesburg, So. Africa; Alfred Herbert, Yokohama; Benson Bros., Sydney, Australia.

Niagara Falls, N. Y.; Chippewa, Ont., Can.; Bauxite, Ark.; Wesseling, Bz. Coln, Germany. Sizes up to 6′ diam. made of Alundum and Crystolon.
Safety Emery Wheel Co., Larch St., Springfield, O. Agents: Farmer & Co., London; Adler & Eisenchitz, Milan; Allied Machinery Co. of America, Paris.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Conn.

Grindstones and Frames
Cleveland Stone Co., Cleveland, Ohio.
Norton Co., Worcester, Mass.

Grindstone Truing Devices
Millers Falls Co., Millers Falls, Mass.

Gun-Barrel Machinery
Pratt & Whitney Co., Hartford, Conn.
Reed-Prentice Co., Worcester, Mass.

Hammers, Drop
Billings & Spencer Co., Hartford, Conn.
Boye & Emmes Mach. Tool Co., Cincinnati, Ohio.
Mayor Bros. Co., Mankato, Minn.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.
Toledo Machine & Tool Co., Toledo, Ohio.

Hammers, Lead
Field, Charles H., Providence, R. I.

Hammers, Power
Bliss & Co., E. W., 1 Adams St., Brooklyn, N. Y
Independent Pneumatic Tool Co., Thor Bldg., Chicago, Ill.
Nazel Eng'g & Mach. Wks., 4041 N. 5th St., Philadelphia, Penn.
Five sizes from 75 lb. to 850 lb. Self-contained, pneumatic or belt or motor drive.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.
Sellers & Co., Inc., Wm., Philadelphia, Penn.

Hammers, Riveting and Chipping
Ingersoll-Rand Co., 11 Broadway, New York.
"Little David" riveters, chippers, calkers, scalers.

Hangers, Shafting
Ball & Roller Bearing Co., Danbury, Conn.
Fafnir Bearing Co., New Britain, Conn.
Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, Penn.
New Departure Mfg. Co., Bristol, Conn.
Royersford Fdry. & Mach. Co., Royersford, Penn.
Standard Pressed Steel Co., Philadelphia, Penn.

Hardening, Casehardening and Tempering
New England Annealing & Tool Co., So. Boston, Mass.
Williams & Co., J. H. Brooklyn, N. Y.

Hardness Measuring Instruments
Shore Instrument & Mfg. Co., 555 W. 22nd St., New York City.

Heat Treating
New England Annealing & Tool Co., South Boston,

Heating and Ventilating Equipment
American Blower Co., 1400 Russell St., Detroit.
Houghton & Co., E. F., 240 W. Somerset St., Philadelphia, Penn.

Hobbing Machines
Adams Co., 1901 Bridge Ave., Dubuque, Iowa.
Barber-Colman Co., Rockford, Ill.
Boston Gear Works, Norfolk Downs, Mass.
Gould & Eberhardt, Newark, N. J.
Four sizes: 12″, 18″, 36″, 72″. For cutting spur, helical or worm gears.
Lees Bradner Co., Cleveland, Ohio.
M.-C. Mfg. Co., 28 Congress St., Newark, N. J.
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn

Hobs
Barber-Colman Co., Rockford, Ill.
Boston Gear Works, Norfolk Downs, Mass.
Gould & Eberhardt, Newark, N. J.
All pitches, carbon or high speed steel, also specially ground teeth form hobs.
Greenfield Tap & Die Corp., Greenfield, Mass.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Union Twist Drill Co., Athol, Mass.

Hoists, Electric
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., Schenectady, N. Y.
Link-Belt Co., 39th St. and Stewart Ave., Chicago, Ill.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.
Northern Engineering Works, Detroit, Mich.
Pawling & Harnischfeger Co., Milwaukee, Wis.
Southwark Fdry. & Mach. Co., Philadelphia, Pa.
Sprague Electric Works, 527 W. 34th St., N. Y. C.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Penn.

Hoists, Hand
Caldwell & Son Co., H. W., Chicago, Ill.
Canton Foundry & Machine Co., Canton, Ohio.
Ford Chain Block & Mfg. Co., 140 W. Oxford St., Philadelphia, Penn.
Harrington, Son & Co., Inc., Ed., Philadelphia, Pa.

Hoists, Pneumatic
Independent Pneumatic Tool Co., Thor Bldg., Chicago, Ill.
Ingersoll-Rand Co., 11 Broadway, New York City.
International Steam Pump Co., 115 Bway., N. Y. C.

Horns, Factory
Benjamin Elec. Mfg. Co., 120 Sangamon St., Chicago, Ill.

Hose, Steel
Sprague Electric Works, 527 W. 34th St., N. Y. C.

Igniters, Gas Engine
Doehler Die Casting Co., Court and Ninth St., Brooklyn, N. Y.

Indexing Machines
Springfield Mach. Tool Co., Springfield, Ohio.

Indicators, Speed
Brown Instrument Co., Philadelphia, Penn.
Starrett Co., L. S., Athol, Mass.
Stewart-Warner Speedometer Corp., Chicago, Ill.
Veeder Mfg. Co., 15 Sargeant St., Hartford, Conn.

Indicators, Test
Norton Grinding Co., Worcester, Mass.
Robinson Co., C. E., Orange, Mass.
Starrett Co., L. S., Athol, Mass.

Inspectors
Souther Engineering Corp., Hy., Hartford, Conn.

Jacks, Hydraulic
Southwark Fdry. & Mach. Co., Philadelphia, Pa.
Watson-Stillman Co., 42 Church St., N. Y. City.

Japans
Moller & Schumann Co., 8 Gerry St., Brooklyn,

Jigs and Fixtures
American Machine & Fdry. Co., 353 Carroll St., Brooklyn, N. Y. New York Office: 200 5th Ave.
Ames Co., B. C., Watham, Mass.
Columbus Die Tool & Mach. Co., Columbus, Ohio.
Cowdrey Mach. Wks., C. H., Fitchburg, Mass.
Eclipse Machine Tool Co., 62 Sudbury, Boston.
Gem City Machine Co., Dayton, Ohio.
Tools, dies, jigs, fixtures, models, all kinds of tool-room work.
Grant Mfg. & Machine Co., 85 Silliman Ave., Bridgeport, Conn
Harris Engineering Co, H. E., Bridgeport, Conn.
Hartford Special Machinery Co., 734 Main St., Hartford, Conn.
Mailometer Co., Detroit, Mich.
Marvin & Casler, Canastota, N. Y.
Modern Tool Die & Mach. Co., Columbus, Ohio.
Mulliner-Enlund Co., 541 S. Clinton St., Syracuse, N. Y.
Mutual Mach. Co., 27 Wells St., Hartford, Conn.
Nelson Tool Co., Inc., 781 E. 142nd St., N. Y. C.
Reynolds Pattern & Machine Co., Moline, Ill.
Rowbottom Machine Co., The, Waterbury, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Stanley Co., 48 Loring Ave., Salem, Mass.
Taft-Peirce Mfg. Co., Woonsocket, R. I.

Kettles, Soda
Gray & Prior Mach. Co., Hartford, Conn.
Manufacturers Equipment & Engineering Co., 209 Washington St., Boston, Mass.
Union Twist Drill Co., Athol, Mass.

Key Seating Machines
Baker Bros., Toledo, Ohio.
Chattanooga Machinery Co., Chattanooga, Tenn. Cable: Radcliffe.
For keyseats $\frac{1}{8}$″ to 5″ wide, 6″ to 40″ long. Weight, 400 lb. to 5,000 lb.
Cuts internal keyways in straight and taper holes with no limit to outside diameter of work. Cutter bar is self-contained with feeding mechanism and self-relieving cutter. Cutters are placed in and removed from bar without use of wrenches or tools. Work centered by bushings fitting to bore. Belt or motor driven.
Lapointe Machine Tool Co., The, Hudson, Mass. Cable Address: "Lapointe," Hudson.
Horizontal type, 4 sizes, capacity up to 4″ wide.
La Salle Machine & Tool Co., La Salle, Ill.
Mitts & Merrill, 913 Tilden St., Saginaw, Mich.
Morton Mfg. Co., Muskegon Heights, Mich.
Stationary keyway cutters, 18 to 48″ stroke.
National Mach. Tool Co., Cincinnati, Ohio.
Internal portable keyseaters.
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.

Keys, Machine
Detroit Twist Drill Co., 644 Fort St., Detroit.
Lapointe Co., J. N., New London, Conn. Cable: Lapointe, New London.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Morton Mfg. Co., Muskegon Heights, Mich.
Standard Gauge Steel Co., Beaver Falls, Penn.
Whitney Mfg. Co., Hartford, Conn.
Williams Co., J. H., 35 Richards St., Brooklyn.

Knives, Machine
Coes Wrench Co., Worcester, Mass.

Knurl Holders
Armstrong Bros. Tool Co., 315 N. Francisco Ave., Chicago, Ill.
Graham Mfg. Co., Providence, R. I.
For turret machines only.
Williams Co., J. H., 35 Richards St., Brooklyn.

Lamp Brackets, Adjustable
Newman Mfg. Co., 717 Sycamore St., Cincinnati, O.

Lamps
Benjamin Elec. Mfg. Co., 120 Sangamon St., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Penn.

Lathe Pans
New Britain Machine Co., New Britain, Conn.

Lathe Tools
Armstrong Bros. Tool Co., 315 N. Francisco Ave., Chicago, Ill.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, Ohio.
Williams Co., J. H., 35 Richards St., Brooklyn.

Lathes, Automatic and Semi-Automatic
Greaves, Klusman Tool Co., Cincinnati, Ohio.
Jones & Lamson Machine Co., Springfield, Vt., U. S. A. Cable Address: Turret. Branch: Jones & Lamson Machine Co., 97 Queen Victoria St., London, E. C., England. Cable: Turretorum.
Sizes: 14″ Fay automatic lathe; swings 14″ over bar, 11″ over carriage, takes 17″ between centers; automatic feed 10″.
For finishing work held on centers or on centered arbors; especially for second operation work carried on arbors. Universal cam adjustments and tool holders permit the use of ordinary forged lathe tools for complicated operations. Machine is entirely automatic, except for changing work.
Agents: Germany, Switzerland, Austria-Hungary, M. Koyemann, Charlotenstrasse 112, Dusseldorf, Germany; France, Spain and Belgium, F. Auberty & Co., 91 Rue de Maubeuge, Paris.
Potter & Johnston Machine Co., Pawtucket, R. I. "P. J. Manufacturing Automatics." 4 sizes, 5A, 6A, 7A, 8A. Range of work varies from about 2½″ diam. to 40″ diam.
Windsor Machine Co., Windsor, Vt., U. S. A. Cable: "Machine," Windsor, Vt.
Gridley multiple-spindle automatics. 3 sizes: ⅜″x4½″, 1¼″x5½″ and 2¼″x7″. Hold four bars of stock in the spindle-carrying cylinder, which revolves step by step, bringing each spindle with its bar successively into alignment with etch tool. The tool slide upon which the tools are mounted and whose axis is concentric with that of the cylinder does not revolve, but through its automatically controlled longitudinal movement it feeds the tools to the work.

Lathes, Bench
Ames Co., B. C., Waltham, Mass.
Blount Co., J. G., Woodland St., Everett, Mass
Oliver Mfg. Co., W. W., Buffalo, N. Y. Cable: Oliver, Buffalo.
Pratt & Whitney Co., Hartford, Conn.
Rivett Lathe & Grinder Co., Brighton, Boston, Mass. Cable: Edrivett.
Five sizes. Capacities: 7″ to 8½″ swing, 18″ to 22″ between centers.
No. 3½, No. 4 and No. 5 plain bench lathes; No. 6, chasing bar lathe; No. 8, back geared screw-cutting lathe.
See our advertisement on inside of back cover.
Seneca Falls Mfg. Co., 687 Water St., Seneca Falls, N. Y.
Stark Tool Co., Watlham, Mass.
Waltham Mach. Works, High St., Waltham, Mass.
Wells & Son Co., F. E., Greenfield, Mass.

Lathes, Boring
Amalgamated Machinery Corp., 72 W. Adams St., Chicago, Ill. Cable: Ampco.
Detrick & Harvey Machine Co., Baltimore, Md. Cable: Detharvey.
For boring light and heavy guns. 3″ to 6″. Any length of bed.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.
Potter & Johnston Machine Co., Pawtucket, R. I.

Lathes, Chucking (See Lathes, Horizontal Turret)

Lathes, Engine
Acme Machine Tool Co., Buck St., Cincinnati, O. Cable Address: Acme.
Amalgamated Machinery Corp., 72 W. Adams St., Chicago, Ill. Cable: Ampco.
American Tool Works Co., The, Cincinnati, U. S. A. Cable: "Lathe, Cincinnati."
Sizes 14, 16, 18, 20, 24, 27, 30, 36, 42″.
Five different types of headstocks: Single back geared, double back geared, triple geared, patented geared head for belt and for motor drive. Quick change gear type and patented top Vee bed.
See our advertisement on pages 14 and 15.
Barnes Co., W. F. & John, 1995 Ruby St., Rockford, Ill.
Barnes Drill Co., Inc., 830 Chestnut, Rockford, Ill
Barrett Mach. Tool Co., Meadville, Penn.
Blount Co., J. G., Woodland St., Everett, Mass.
Boye & Emmes Mach. Tool Co., Cincinnati, Ohio.
Bradford Mach. Tool Co., Cincinnati, Ohio.
Bullard Mach. Tool Co., Bridgeport, Conn.
Special single purpose machines for turning shells and projectiles.
Carroll Jamieson Mach. Co., Batavia, Ohio.
Champion Tool Works Co., 2424 Spring Grove Ave., Cincinnati, Ohio.
Cincinnati Lathe & Tool Co., Oakley, Cincinnati, O.
Sizes 14, 16 and 18 in.

HEALD MAGNETIC CHUCK

UNIFORM HOLDING POWER

THE holding power over the entire face of the chuck will not vary 5% across any two poles. This uniformity enables you to cover the entire magnetic surface with small or large pieces and requires no changing of plates. It also permits rapid replacing of pieces and heavier cuts. This effects a tremendous saving in machining costs.

Whether you maintain planers, milling machines, grinding machines or lathes, Heald Magnetic Chucks —rectangular or rotary type—can be used to advantage. Ask us how.

THE HEALD MACHINE CO. **10 New Bond Street, WORCESTER, MASS.**

Branches: Chicago Detroit Cleveland Cincinnati

Agents for Great Britian, Alfred Herbert, Ltd., Coventry. Agents for France, Alfred Herbert, Ltd., Paris.

A New Idea In SCREWS

Allen Socket Cap Screws fulfill every requirement of the ordinary slotted head fillister screws and **"Allens"** make a smooth, neat appearing job.

There are none of the former troubles due to screw driver slots becoming rounded off or broken while making the adjustments required when assembling the new machines.

"Allen" Socket Cap Screws

meet the need of machine tool builders who require a stronger screw than the ordinary fillister head slotted kind. A prominent user told us that **Allen Socket Cap Screws** improve the looks of his machines fully 25%.

"Allens" can be set up hard and loosened as often as desired without marring the head in the slightest.

They are threaded accurately to standard gauges and are perfect in lead. The heads are perfectly true with the body of screw, thus saving the bother of having to grind off one side of screw to fit the counterbore as is often necessary with the usual run of round slotted cap screws.

Send for Circular No. 10 of Socket Cap Screws and Safety Set Screws. Free samples on request.

The Allen Manufacturing Co., 135 Sheldon St., Hartford, Conn.

173 Princess Street, Manchester, England.

Cleveland Crane & Eng'g Co., Wickliffe, Ohio.
Cook Mfg. Co., Inc., C. Lee, Louisville, Ky.
24", 10', 12', and 14" beds.
Davis Mach. Tool Co., Inc., 311 St. Paul St., Rochester, N. Y.
Dreses Machine Tool Co., Cincinnati, Ohio.
Fitchburg Machine Works, Fitchburg Mass.
Flather & Co., Inc., Nashua, N. H.
Greaves, Klusman Tool Co., Cincinnati, Ohio.
Harrington, Son & Co., Inc., Ed., Philadelphia, Pa.
Hendey Machine Co., The, Torrington, Conn. Cable: Hendey, Torrington. Branches: Singer Bldg., New York City; Oliver Bldg., Boston; Sharples Bldg., Chicago.
Sizes made—12, 14, 16, 18, 20, 24" swing; lengths of bed from 4' to 24' according to swing. Quick change geared. Have taper bearings with ring oiling system for main spindle, and gearing is so arranged that extra gears can be added in train without limit for cutting extra threads if wanted.
Agents: Sherritt & Stoer, Philadelphia; Syracuse Supply Co., Syracuse and Bufftlo; W. M. Pattison Supply Co., Cleveland, Dayton, Detroit; Colcord-Wright Mchy. & Supply Co., St. Louis; Pacific Tool & Supply Co., San Francisco; A. R. Williams Mchy. Co., Toronto; Williams & Wilson, Montreal; Chas. Churchill & Co., London; D. Drury & Co., Johannesburg.
Hill, Clarke & Co., Inc., 156 Oliver, Boston, Mass.
Jenckes Knitting Mach. Co., Pawtucket, R. I.
Turns up to 5 pieces simultaneously according to length.
Jenckes Machine Co., Ltd., Sherbrooke, Quebec, Canada.
Single purpose lathes for shell operations. Equipped with air chucks and friction drives. Turning high explosive shells.
LeBlond Machine Tool Co., R. K., Cincinnati, O.
Lodge & Shipley Machine Tool Co., Cincinnati, O. Cable: Drill.
Sizes 14 to 48" swing, any length bed. Quick change gear, screw-cutting engine lathes, cone head. Also with single pulley, all geared selective head.
Monarch Machine Tool Co., Sidney, Ohio.
14", 16", 18" and 20" swing.
Mueller Machine Tool Co., Cincinnati, Ohio.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.
Oliver Machinery Co., Grand Rapids, Mich.
Pittsburgh Machine Tool Co., Braddock, Penn.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., Singer Bldg., N. Y. C.
Reed-Prentice Co., Worcester, Mass.
Sebastian Lathe Co., 117 Culvert St., Cincinnati, O.
Seneca Falls Mfg. Co., 687 Water St., Seneca Falls, N. Y. 13", 14", 15" swing.
Springfield Machine Tool Co., The, Springfield, Ohio. Cable: Montanus.
Sizes 14, 16, 18, 20, 24, 30, 36-in. swing. Capacities—Any length beds and all special equipment. Three sizes Fox monitor lathes, 15, 18 and 20" swing. Single pulley all geared head lathes, 14, 16, 18" swing.
Strong, Carlisle, Hammond Co., Cleveland, Ohio.
Toomey, Inc., Frank, Philadelphia, Penn.
Windsor Machine Co., Windsor, Vt.

Lathes, Extension and Gap
American Tool Works Co., Cincinnati, Ohio.
Barnes Drill Co., 830 Chestnut St., Rockford, Ill.
Harrington, Son & Co., Inc., Ed., Philadelphia, Pa.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.

Lathes, Foot Power
Barnes Co., W. F. & John, 1995 Ruby St., Rockford, Ill.
Reed-Prentice Co., Worcester, Mass.
Seneca Falls Mfg. Co., 687 Water St., Seneca Falls, N. Y.
Wells & Son Co., F. E., Greenfield, Mass.

Lathes, Horizontal Turret
Acme Machine Tool Co., Buck St., Cincinnati, Ohio. Cable Address: Acme.
Flat turret type (two sizes), bar work 2¼" and 3¼" diameter. Chucking work 12" and 16" diameter. High turret type (four sizes), 14" to 20" swing.
American Tool Wks. Co., Cincinnati, Ohio.
Blount Co., J. G., Woodland St., Everett, Mass.
Bradford Mach. Tool Co., Cincinnati, Ohio.
Champion Tool Wks. Co., 2424 Spring Grove Ave., Cincinnati, Ohio.
Cleveland Crane & Engineering Co., Wickliffe, O.
Davis Machine Tool Co., Inc., 311 St. Paul St., Rochester, N. Y.
Dreses Machine Tool Co., 227-241 W. McMicken Ave., Cincinnati, O. Cable: Dreses, Cincinnati. Sizes—13" to 20" swing.
With plain and universal slides. Plain and friction back geared. Power feed Belt and motor driven.
Jones & Lamson Machine Co., Springfield, Vt., U. S. A. Cable: Turret. Branch: Jones & Lamson Machine Co., 97 Queen Victoria St., London, E. C., England. Cable: Turretorum.
Sizes — 2¼", 3" and double spindle; 12" and 14" swing respectively for single spindle, and 10" for double spindle, or 17" when used as a single spindle machine.
Has flat turret and cross sliding head, universal tool holders and simple forged tools. Complicated work set up quickly without special tooling; suitable for small lots or continuous manufacturing. Double spindle machine similar in principle and equipment, but does two pieces of work at the same time, for high production work, 2¼ and 3" machines also sold with bar outfits.
Agents: Germany, Switzerland, Austria-Hungary, M. Koyemann, Charlottenstrasse 112, Dusseldorf, Germany; France, Spain and Belgium, F. Auberty & Co., 91 Rue de Maubeuge, Paris.
Oliver Machinery Co., Grand Rapids, Mich.
Potter & Johnston, Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Reed-Prentice Co., Worcester, Mass.

Lathes, Polishing
(See Buffing or Polishing Machines)

Lathes, Speed and Hand
Garvin Mach. Co., Spring and Varick St., N. Y. C.
LeBlond Machine Tool Co., R. K., Cincinnati, O.
Reed-Prentice Co., Worecster, Mass.
Seneca Falls Mfg. Co., 687 Water St., Seneca Falls, N. Y.
Wells & Son Co., F. E., Greenfield, Mass.

Lathes, Vertical Turret
Bullard Machine Tool Co., Bridgeport, Conn.
Bullard vertical turret lathe, "New Era" type. 18" size; capacity, 22 diam., height from face of chuck table to underside of turret saddle 10½"; from face of table to face of turret 22". 24" size, capacity 26" diam., 20" height under crossrail, 28½" under turret face, table 24½" diam. 34" size, 36" diam., 24½" height under crossrail, 33" under turret face, table 32½" diam. 36" size, 38" diam., 24½" height under crossrail, 35" under turret face, table 34" diam. 42" size, 44" diam., 33" height under crossrail, 43½" under turret face, table 42⅝" diam. Also made without side head for large diameter work, requiring simple operations.
Agents: Australia, Benson Bros., Sydney; France, Fenwick Freres & Co., Paris; England, Alfred Herbert, Coventry; The Netherlands, Landre & Glinderman, Amsterdam; Russia, G. Koeppen & Co., Moscow; Germany, Heinrich Dreyer, Berlin; Sweden, Axel Ryden, Stockholm.
Foster Machine Co., Elkhart, Ind.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.

Lathes, Wood Turning
Barnes Co., W. F. & John, 1995 Ruby St., Rockford, Ill.
Oliver Machinery Co., Grand Rapids, Mich.
Seneca Falls Mfg. Co., 687 Water St., Seneca Falls, N. Y.
Wells & Son Co., F. E., Greenfield, Mass.

Letters and Figures
Hoggson & Pettis Mfg. Co., New Haven, Conn.

Levels, Spirit
Starrett Co., L. S., Athol, Mass.

Lighting Fixtures
Newman Mfg. Co., 717 Sycamore St., Cincinnati, O.

Lockers, Clothes
Manufacturing Equipment & Engineering Co., 209 Washington St., Boston, Mass.

Locomotive Box Boring Machines
Detrick & Harvey Mach. Co., Baltimore, Md.
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.

Lubricants
Crescent Oil Co., 50 Church St., New York City.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Houghton & Co., E. F., 240 W. Somerset St., Philadelphia, Penn.
Oil City Oil & Grease Co., Oil City, Penn.
Texas Company, Dept. A, 17 Batery Place, N. Y.
White & Bagley Co., Worcester, Mass.
Cylinder, engine and machine oils. "Minolard" cutting oil for automatics.
Richardson-Phenix Co., 119 Reservoir Ave., Milwaukee, Wis.

Lubricators
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.

Machinists' Small Tools
Athol Machine Co., Athol, Mass.
Bemis & Call Hardware & Tool Co., Springfield, Mass.
Billings & Spencer Co., Hartford, Conn.
Cleveland Twist Drill Co., Cleveland, Ohio.
Garvin Mach. Co., Spring and Varick St., N. Y. C.
Greenfield Tap & Die Corp., Greenfield, Mass.
Hammacher & Schlemmer Co., 13th St. and 4th Ave., New York City.
Pratt & Whitney Co., Hartford, Conn.
Randall & Stickney, Waltham, Mass.
Robinson Co., C. E., Orange, Mass.
Smith & Hemanway Co., 150 Chambers St., N.Y. C.
Standard Tool Co., Cleveland, Ohio.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Williams Co., J. H., 35 Richards St., Brooklyn.

Mandrels, Expanding
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Nicholson Co., W. H., 114 Oregon St., Wilkes-Barre, Penn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, Ohio.

Mandrels, Solid
Cleveland Twist Drill Co., E. 49th St and Lakeside Ave., Cleveland, Ohio. New York, 30 Reade St.; Chicago, 9 N. Jefferson St.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
National Twist Drill & Tool Co., Detroit, Mich.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, Ohio.

Measuring Machines
Norma Co. of America, 1790 Bway., New York.
Pratt & Whitney Co., Hartford, Conn.

Metal Finishes
Moller & Schumann Co., 8 Gerry St., Brooklyn.

Meters, Steam Flow
General Electric Co., Schenectady, N. Y.
Richardson-Phenix Co., 119 Reservoir Ave., Milwaukee, Wis.

Micrometer Calipers
Brown & Sharpe Mfg. Co., Providence, R. I.
475 sizes. Styles to meet every practical requirement in shop work. Also put up in sets to meet a broad range of tool-room and inspection requirements.
Randall & Stickney, Waltham, Mass.
Reed & Prince Mfg. Co., Worcester, Mass.
Slocomb Co., J. T., Providence, R. I. Chicago store, R. R. Street & Co., 541 W. Washington St. Sizes ½"—1" to 24", each with a range of 1" and corresponding sizes in metric measure. Capacities 24" to 27", 27" to 30", 30" to 33", 33" to 36"; nearest sizes metric graduated to $^1/_{100}$ millimeters, and English $^1/_{1000}$" and $^1/_{10000}$".
Starrett Co., L. S., Athol, Mass.

Milling Attachments
Adams Co., 1902 Bridge Ave., Dubuque, Iowa
Becker Milling Machine Co., Hyde Park, Mass.
Cincinnati Milling Machine Co., Oakley, Cincinnati, Ohio.
Garvin Mach. Co., Spring and Varick St., N. Y. C.
Hendey Mach. Co., Torrington, Conn.
Ingersoll Milling Machine Co., The, Rockford, Ill.
Attachments for special purposes applied to old and new Ingersoll machines particularly. Advertisement page 8.
Kearney & Trecker Co., Milwaukee, Wis.
Kempsmith Mfg. Co., Milwaukee, Wis.
LeBlond Machine Tool Co., R. K., Cincinnati, O.
Potter & Johnston Machine Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Rivett Lathe & Grinder Co., Brighton, Boston.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Van Norman Machine Tool Co., Wibraham Ave., Springfield, Mass.
Whitney Mfg. Co., Hartford, Conn. Cable: Whitney, Hartford.

Milling Machines, Bench
Ames Co., B. C., Waltham, Mass.
Carter & Hakes Machine Co., Winsted, Conn.
Pratt & Whitney Co., Hartford, Conn.
Stark Tool Co., Waltham, Mass.
Van Norman Machine Tool Co., Wilbraham Ave., Springfield, Mass.

Milling Machines, Hand
Adams Co., 1902 Bridge Ave., Dubuque, Iowa.
Becker Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Carter & Hakes Machine Co., Winsted, Conn.
Cincinnati Milling Machine Co., Oakley, Cincinnati, Ohio.
Garvin Mach. Co., Spring and Varick St., N. Y. C.
Pratt & Whitney Co., Hartford, Conn.
Steptoe Co., The John, Northside, Cincinnati, O.
Van Norman Machine Tool Co., Wilbraham Ave., Springfield, Mass.
Whitney Mfg. Co., Hartford, Conn. Cable: Whitney, Hartford.

Milling Machines, Horizontal and Planer Type
Adams Co., 1902 Bridge Ave., Dubuque, Iowa.
Beaman & Smith Co., Providence, R. I.
Becker Milling Machine Co., Hyde Park, Mass.
Hill, Clarke & Co., Inc., 156 Oliver, Boston, Mass.
Ingersoll Milling Machine Co., The, Rockford, Ill.
All sizes and designs—ask for bulletin 36. Specialists in this line of fixed and adjustable crossrail machines.
Advertisement page 8.
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.
Sellers & Co., Inc., Wm., Philadelphia, Penn

Milling Machines, Oil Grooving
Chattanooga Machinery Co., Chattanooga, Tenn.
Fischer Machine Co., Philadelphia, Penn.
National Machine Tool Co., Cincinnati, Ohio.
Internal port. oil groovers for drilling mach.

Milling Machines, Plain
Adams Co., 1902 Bridge Ave., Dubuque, Iowa.
Becker Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
19 sizes—9 cone drive, 10 constant speed. Range of feeds from 18"x6"x15" to 50"x14"x21" Table working surfaces range from 22½"x8⅛" to 73"x22½".
For branches and agents see our advertisement.
Cincinnati Milling Machine Co., Oakley, Cincinnati, Ohio.
Garvin Mach. Co., Spring and Varick St., N. Y. C.
Hendey Machine Co., Torrington, Conn. Cable: "Hendey." Branches: Oliver Bldg., Boston;

The Balance in Favor of "TEXACO"

RECENTLY an engineer of a large Mid-Western Plant told us of the behavior of TEXACO URSA OIL on his 750 H.P. twin gas engine units operating on Producer Gas.

He started on this high-grade TEXACO LUBRICANT after having considerable trouble.

One of his worries with the old oil was the job of removing, cleaning, and adjusting the stuffing boxes monthly.

He told us that he has used

TEXACO URSA OIL

on these engines for one year. During this time he has never had occasion to touch the stuffing boxes for any reason whatever.

The balance in favor of TEXACO URSA OIL is further augmented by the tale of the log which shows 30% reduction in the total monthly cost for oil, notwithstanding the fact that TEXACO URSA OIL costs more per gallon than the product formerly used.

Case after case like this comes to our notice. True, sometimes, the savings are not as great as this—but upon the record of thousands of engines and plants, we can predict a very definite improvement in your power plant or shop.

Put your lubricating problems up to TEXACO SERVICE. See how you will benefit by our experience, plus the selection and application of TEXACO LUBRICANTS to your particular problems.

TEXACO

THE TEXAS COMPANY

Department "A," 17 Battery Place, N. Y.

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BRANCH OFFICES:

Boston
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Philadelphia

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Youngstown
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El Paso
Chicago
Oklahoma City

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TEXACO

Singer Bldg., New York City, and 565 Washington Blvd., Chicago.
Sizes—Nos. 1, 2, 3 and 4. Belt cone types in Nos. 1, 2 and 3; all geared drive types in Nos. 2, 3 and 4.
Agents: W. M. Pattison Supply Co., Cleveland, Detroit; Syracuse Supply Co., Syracuse, Buffalo; Sherritt & Stoer Co., Philadelphia; Laughlin-Barney Mchy. Co., Pittsburgh; A. R. Williams Mchy. Co., Toronto, Winnipeg, St. John and Vancouver; Williams & Wilson, Ltd., Montreal; C. W. Burton, Griffiths & Co., London.
Hill, Clarke & Co., Inc., 156 Oliver St., Boston.
Ingersoll Milling Machine Co., The, Rockford, Ill.
For knee type machines. Make specialty of combined horizontal and vertical machines. Bulletin 31-I.
See advertisement, page 8.
Kearney & Trecker Co., Milwaukee, Wis.
Kempsmith Mfg. Co., Station A, Milwaukee, Wis. Cable: Kempsmith, Milwaukee.
Three sizes, 2 sizes Lincoln type.
LeBlond Machine Tool Co., R. K., Cincinnati, O.
Morton Mfg. Co., Muskegon Heights, Mich.
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.
Oesterlein Machine Co., Cincinnati, Ohio.
Potter & Johnston Machine Co., Pawtucket, R. I.
Steptoe Co., The John, Northside, Cincinnati, O.
Van Norman Mach. Tool Co., Wilbraham Ave., Springfield, Mass.
Whitney Mfg. Co., Hartford, Conn. Cable: Whitney, Hartford.

Milling Machines, Portable
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.
Underwood & Co., H. B., 1026 Hamilton St., Philadelphia, Penn.

Milling Machines, Thread
Pratt & Whitney Co., Hartford, Conn.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Waltham Mach. Works, High St., Waltham, Mass.

Milling Machines, Universal
Becker Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
11 sizes—4 cone drive, 7 constant speed. Range of feeds from 22″x8″x18″ to 42″x14″x20″. Table working surfaces range from 36¼″x10¾″ to 64½″x17½″. Range of index centers, swing 10″ to 15″; take work between centers from 19″ to 41½″ in length.
For branches and agents see our advertisement.
Cincinnati Milling Machine Co., Oakley, Cincinnati, Ohio.
Garvin Mach. Co., Spring and Varick St., N. Y. C.
Hendey Machine Co., Torrington, Conn. Cable: Hendey. Branches: New York, Boston, Chicago.
Sizes Nos. 1, 2, 3, 4. Belt cone type in Nos. 1, 2, 3; all gear drive type in Nos. 1, 2, 3, 4.
Hill, Clarke & Co., Inc., 156 Oliver St., Boston.
Kearney & Trecker Co., Milwaukee, Wis.
Kempsmith Mfg. Co., Station A, Milwaukee, Wis. Cable: Kempsmith, Milwaukee. Three sizes.
LeBlond Machine Tool Co., R. K., Cincinnati, O.
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.
Oesterlein Machine Co., Cincinnati, Ohio.
Potter & Johnston Machine Co., Pawtucket, R. I.
Automatic milling machines for continuous milling equipped with two tables mounted on turret base.
Van Norman Machine Tool Co., Wilbraham Ave., Springfield, Mass.

Milling Machines, Vertical
Adams Co., 1901 Bridge Ave., Dubuque, Iowa.
Becker Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
4 sizes—2 cone drive, 2 constant speed. Range of feeds: Longitudinal, 22″ to 52″; transverse, 12″ to 16″; vertical, knee, 14″ to 16″; spindle head, 4″ to 8″. Table working surfaces range from 37″x11½″ to 52″x16″.
For branches and agents see our advertisement.
Cincinnati Milling Machine Co., Oakley, Cincinnati, Ohio.
Garvin Mach. Co., Spring and Varick St., N. Y. C.
Hill, Clarke & Co., Inc., 156 Oliver St., Boston.
Ingersoll Milling Machine Co., The, Rockford, Ill.
Get bulletin No. 31-I. Advertisement page 8.
Kearney & Trecker Co., Milwaukee, Wis.
Knight Machinery Co., W. B., 2000 Lucas Ave., St. Louis, Mo.
LeBlond Machine Tool Co., R. K., Cincinnati, O.
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.
Potter & Johnston Machine Co., Pawtucket, R. I.
Automatic milling machines for continuous milling equipped with two tables mounted on turret base.
Sellers & Co., Inc., Wm., Philadelphia, Penn.
Van Norman Mach. Tool Co., Wilbraham Ave., Springfield, Mass.

Milling Machines, Worm
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.
Waltham Mach. Works, High St., Waltham, Mass.

Molds, Lead
Field, Charles H., Providence, R. I.

Motors, Electric
C & C Elec. & Mfg. Co., Garwood, N. J.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., Schenectady, N. Y.
Reliance Electric & Engineering Co., 1044 Ivanhoe Road, Cleveland, Ohio. Branches: New York, Philadelphia, Chicago.
D. C. Constant speed. Adjustable speed field resistance control type, speed ranges up to 1:4. Adjustable speed armature shifting type speed ranges up to 1:10. Armature shifting type provides unlimited running speeds within its range. A. C. Squirrel cage and slip ring types.
Parts for changing belt-driven machine tools to motor-drive designed, manufactured and applied.
Sprague Electric Works, 527 W. 34th St., N. Y. C.
Stow Mfg. Co., Binghamton, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Penn.

Name Plates
Franklin Mfg. Co., 400 S. Geddes St., Syracuse.

Nut Tappers (See Bolt and Nut Machinery)

Oil Burners
Best, W. N., 11 Broadway, New York City.
Gilbert & Barker Mfg. Co., 11 Union St., Springfield, Mass.

Oil and Grease Cups
Bay State Stamping Co., Worcester, Mass.
Bowen Mfg. Co., Auburn, N. Y. New York City, Chicago, San Francisco.
Doehler Die Casting Co., Court and Ninth St., Brooklyn, N. Y. Branch: Toledo, Ohio. Cable: Doehler, Brooklyn.
Wahlstrom Tool Co., Brooklyn, N. Y.

Oilers
Gem Mfg. Co., 3257 Spruce St., Pittsburgh, Pa.
Patent and plain spouts, brazed steel, ⅜, ½, ¾, 1 pt.
Richardson-Phenix Co. 119 Reservoir Ave., Milwaukee, Wis.

Oiling Systems
Richardson-Phenix Co., 119 Reservoir Ave., Milwaukee, Wis.
Oil filters and automatic systems for circulating, filtering and sterilizing cutting oils and compounds.

Oils
Crescent Oil Co., 30 Church St., New York City.
Houghton & Co., E. F., 240 W. Somerset St., Philadelphia, Penn.
Texas Company, Dept. A, 17 Battery Pl., N. Y. City.
White & Bagley Co., Worcester, Mass.

Oil Stones
American Emery Wheel Works, Providence, R. I.
Carborundum Co., Niagara Falls, N. Y. New York City, Chicago, Boston, Philadelphia, Cleveland, Cincinnati, Pittsburgh, Milwaukee, Grand Rapids, Manchester, Eng.; Dusseldorf, Germany.
Norton Co., Worcester, Mass.
Vitrified Wheel Co., Westfield, Mass.

Oxygen
Davis-Bournonville Co., Jersey City, N. J.
International Oxygen Co., 115 Bway., N. Y. C.
Linde Air Products Co., 42nd St. Bldg., N. Y. C.

Packing, Hydraulic
Chicago (Ill.) Rawhide Mfg. Co., 1301 Elston Ave.
Graton & Knight Mfg. Co., Worcester, Mass.
Houghton & Co., E. F., 240 W. Somerset St., Philadelphia, Penn.
Southwark Fdry. & Mach. Co., Philadelphia, Pa.

Packing, Steam
Graton & Knight Mfg. Co., Worcester, Mass.
Greene, Tweed & Co., 109 Duane St., N. Y. City.

Painting Machines
Spray Engineering Co., 91 Federal St., Boston,

Paints, Machinery
Felton, Sibley & Co., Inc., 136 N. 4th St., Phila.
Moller & Schumann Co., 8 Gerry St., Brooklyn,

Pattern Shop Machinery (See Woodworking Machinery)

Phosphor Bronzes
American Bronze Co., Berwyn, Penn. 429 Ford Bldg., Detroit, Mich. Cable: Ambrocom, Phila.
Germann Bronze Co., 345 W. 19th St., Erie, Penn.
Bunting Brass & Bronze Co., 726 Spencer St., Toledo, Ohio.

Pipe Bending Machines
Treadwell Engineering Co., 88 West St., N. Y. C.
Underwood & Co., H. B., 1026 Hamilton St., Philadelphia, Penn.

Pipe Cutting and Threading Machines
Bignall & Keeler Mach. Wks., Edwardsville, Ill. Cable: Bikeeler.
Nine sizes, capacities ¼″ to 2″, ¼″ to 3″, 1″ to 4″, 1¼″ to 6″, 2½″ to 8″, 3½″ to 10″, 4″ to 12″, 7″ to 16″, 8″ to 18″.
Detrick & Harvey Mach. Co., Baltimore, Md.
Greenfield Tap & Die Corp., Greenfield, Mass.
Landis Machine Co., Waynesboro, Penn.
Sizes 1 to 8″ inclusive.
Murchey Mach. & Tool Co., 64 Porter St., Detroit.
Saunders Sons, D., Yonkers, N. Y.
Standard Engineering Works, Ellwood City, Pa.
Treadwell Engineering Co., 88 West St., N. Y. C.
Trimont Mfg. Co., 55 Amory St., Roxbury, Mass.
"Trimo" pipe cutters, hand operater, 3 sizes, cutting pipe ⅛″ to 8″.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Pipe Fitters' Tools
Brubaker & Bros., W. L., Millersburg, Penn.
Butterfield & Co., Derby Line, Vt.
Cleveland Twist Drill Co., Cleveland, Ohio
Greenfield Tap & Die Corp., Greenfield, Mass.
Pratt & Whitney Co., Hartford, Conn.
Saunders Sons, D., Yonkers, N. Y.
Southwark Fdry. & Mach. Co., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.
Trimont Mfg. Co., 55 Amory St., Roxbury, Mass.
Wells & Son Co., F. E., Greenfield, Mass.
Williams Co., J. H., 35 Richards St., Brooklyn.

Piston-Ring Machines
Heald Machine Co., 10 New Bond St., Worcester, Mass.
Potter & Johnston Machine Co., Pawtucket, R. I.
Capacity pistons 3″ up to 8½″ diameter up to 12″ long. Piston rings 3″ up to 8½″ diam., any width required. Send for circular 24.
Pratt & Whitney Co., Hartford, Conn.
Walker Co., O. S., Worcester, Mass.
Windsor Machine Co., Windsor, Vt., U. S. A. Cable: "Machine," Windsor, Vt.
Gridley piston and ring machines are semi-automatic. Turn the outsides of the rings eccentric at the same time that the insides of the rings are being bored concentric. Make pistons and rings up to 6″ in diameter.

Planer, Parallels
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Walker Co., O. S., Worcester, Mass.

Planing Machines
American Tool Works Co., The, Cincinnati, U. S. A. Cable: "Lathe, Cincinnati."
Sizes 24, 26, 28, 30, 36, 42, 48, 60″ between housings. Built with 1, 2, 3 or 4 heads and 6 different types of drive: Single speed, belt or motor drive; double speed through 2-speed countershaft; 4 speed, through patented cone speed variator for belt or motor drive and with variable speed motor drive with reversing motor equipment. All sizes are equipped aluminum tight pulleys.
See our advertisement on pages 14 and 15.
Cincinnati Planer Co., The, Cincinnati, Ohio. Cable: Planer.
22″ to 96″ planers, frog and switch, shoe and wedge and cylinder planers.
Patent "Tu-Speed" type, quick reverse aluminum pulleys, all gearing inside beds, safetly locking device, simplex feed gears, patent power elevating device, patent tumbler and dogs, ball bearings on feed screws.
Agents: Prentiss Tool & Supply Co., New York; W. E. Shipley Mchy. Co., Philadelphia; Motch & Merryweather Co., Cleveland, Ohio; Marshall & Huschart Co., Chicago.
Cleveland Planer Works, 3148 Superior Ave., Cleveland, Ohio. Open side, frog and switch. Seven sizes. Capacities 26″ to 72″, any length.
Detrick & Harvey Machine Co., Baltimore, Md. Cable: Detharvey.
Open side. 30″ to 96″. For wide work beyond limits of double housing planes. Spiral gear drive. Open side convertible. 42″ to 96″. For double housing planer work. Addition of outer housing turns open side planer into double housing planer. Spiral pinion drive. Double housing—42″ to 120″. For uninterrupted double housing planer work. Spur gear drive. All beds of closed box type. Motor or belt driven. Automatic or hand feeds. Steel cut gears.
Fitchburg Machine Works, Fitchburg, Mass.
Gray Co., The G. A., Cincinnati, Ohio. Cable: Gray, Cincinnati.
Thirty sizes, 22″x22″ to 84″x60″.
Spur geared and spiral geared, constant and variable speed, belt and motor driven.
Agents: Hill, Clarke & Co., Boston and Chicabo; Vandyck Chuchill Co., New Haven; Swind Machinery Co., Phila.; Carey Mach. & Sup. Co., Baltimore; Brown & Zortman Mach. Co., Pittsburgh; Strong, Carlisle & Hammond Co., Cleveland and Detroit; E. A. Kinsey Co., Cincinnati and Indianapolis; Colcord-Wright Mach. & Sup. Co., St. Louis; F. E. Satterlee Co., Minneapolis; Mine & Smelter Sup. Co., Denver; Pacific Tool & Sup. Co., San Francisco; Perine Mchry. Co., Seattle; Foss & Hill Mach. Co., Montreal; H. W. Petrie, Ltd., Toronto.
Hill, Clarke & Co., Inc., 156 Oliver St., Boston.
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.
Ohio Machine Tool Co., Leighton St., Kenton, O.
Prentiss Tool & Supply Co., Singer Bldg., N. Y. C.
Sellers & Co., Inc., Wm., Philadelphia, Penn.
Strong, Carlisle, Hammond Co., Cleveland, Ohio.
Toomey, Inc., Frank, Philadelphia, Penn.
Woodward & Powell Planer Co., Worcester, Mass.

Planing Machines, Portable
Morton Mfg. Co., Muskegon Heights, Mich.
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.

NICHOLSON
U.S.A.
(TRADE MARK)

His Smile Proves That His Men Were Right In Asking For Nicholson Files

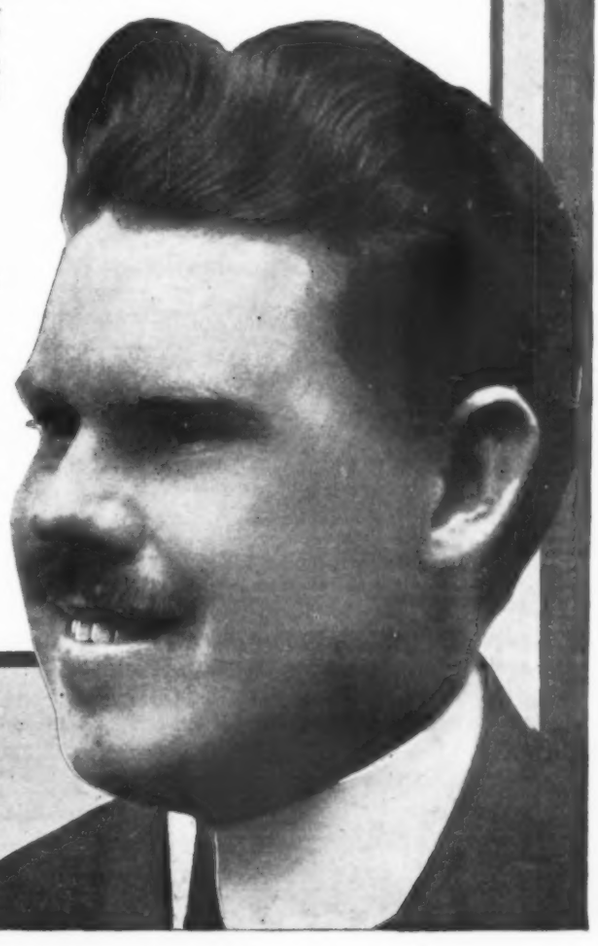
That smile vindicates the judgment of the men in the shop who asked for **Nicholson Files.**

In response to the demand, **Nicholson Files** were ordered. The good results quickly showed at the work benches and spread to the executive department. There they showed in a dollars-and-cents saving on file expenses and were reflected on the face of the man who pays the bills.

Incidentally the mechanics who had been advocating the use of **Nicholson Files** stand well in the estimation of the men higher up.

Nicholson Files achieve results by their good qualities, fine workmanship, keen cutting ability and long life. No delay in shipping. There are over 6,000 different varieties of sizes, shapes and cuts always in stock.

Let us send you a copy of **"File Filosophy,"** an interesting booklet covering the care and use of files.



Nicholson File Co.

Providence, R. I., U. S. A.

Planing Machines, Rotary
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.
Underwood & Co., H. B., 1026 Hamilton St., Philadelphia, Penn.

Plate Rolls
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.

Pneumatic Tools
Independent Pneumatic Tool Co., Thor Bldg., Chicago, Ill.
Ingersoll-Rand Co., 11 Broadway, New York City.
Chicago Pneumatic Tool Co., Thor Bldg., Chicago, Ill.

Presses, Arbor
Atlas Press Co., 310 Park St., Kalamazoo, Mich.
Barnes Co., W. F. & John, 1995 Ruby St., Rockford, Ill.
Wilmarth & Morman Co., 1187 Monroe Ave., Grand Rapids, Mich.

Presses, Banding
Cleveland Crane & Engineering Co., Wickliffe, O.

Presses, Broaching
Atlas Press Co., 310 Park St., Kalamazoo, Mich.
Bliss & Co., E. W., 1 Adams St., Brooklyn, N. Y.

Presses, Drop and Forging
Billings & Spencer Co., Hartford, Conn.
Bliss & Co., E. W., 1 Adams St., Brooklyn, N. Y.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.
Toledo Machine & Tool Co., Toledo, Ohio.

Presses, Foot and Hand
Atlas Press Co., 310 N. Park St., Kalamazoo, Mich.
Bliss & Co., E. W., 1 Adams St., Brooklyn, N. Y.
Ferracute Machine Co., Bridgeton, N. J.
Royersford Fdry. & Mach. Co., Royersford, Penn. Heavy machine for light metal stamping.
Shuster Co., The F. B., New Haven, Conn.
Taylor & Fenn Co., The, Hartford, Conn.

Presses, Forcing
Atlas Press Co., 310 N. Park St., Kalamazoo, Mich.
Barnes Co., W. F. & John, 1995 Ruby St., Rockford, Ill.
Billings & Spencer Co., Hartford, Conn.
Bliss & Co., E. W., 1 Adams St., Brooklyn, N. Y.
Lucas Machine Tool Co., E. 99th St. and N. Y. C. R.R., Cleveland. Cable: Lucas, Cleveland. Three sizes. Capacities, 15, 30 and 50 tons. Power machines for operations requiring pressure, such as forcing arbors, bushings, shafts or pins in or out of holes, bending, or straightening, broaching, etc.

Presses, Hydraulic
Bethlehem Steel Co., Machinery Dept., South Bethlehem, Penn.
Cleveland Crane & Engineering Co., Wickliffe, O.
Elmes Eng. Works, Chas. F., 1001 Fulton St., Chicago, Ill.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.
Sellers & Co., Inc., Wm., Philadelphia, Penn.
Southwark Fdry. & Mach. Co., Philadelphia, Pa.
Watson-Stillman Co., 42 Church St., N. Y. City.

Presses, Pneumatic and Steam
Bethlehem Steel Co., Machinery Dept., South Bethlehem, Penn.
Bliss & Co., E. W., 1 Adams St., Brooklyn, N. Y.
Southwark Fdry. & Mach. Co., Philadelphia, Pa.

Presses, Power
Barnes Co., W. F. & John, 1995 Ruby St., Rockford, Ill.
Blake & Johnson Co., The—Waterbury, Conn.
Bliss & Co., E. W., 1 Adams St., Brooklyn, N. Y.
Ferracute Machine Co., Bridgeton, N. J.
La Salle Machine & Tool Co., La Salle, Ill.
Niagara Mach. & Tool Works, Buffalo, N. Y.
Robinson Mfg. Co., The J. M., Cincinnati, Ohio.
Rowbottom Machine Co., The, Waterbury, Conn.
Springfield Mach. Tool Co.—Springfield, Ohio.
Toledo Machine & Tool Co., Toledo, Ohio.

Presses, Screw
Barnes Co., W. F. & John, 1995 Ruby St., Rockford, Ill.
Bliss & Co., E. W., 1 Adams St., Brooklyn, N. Y.

Presses, Sub
Blake & Johnson Co., The, Waterbury, Conn.

Press Guards
Safety Engineering Co., 1440 Schoffield St., Cleveland, Ohio.

Profiling Machines
Becker Milling Machine Co., Hyde Park, Mass.
Detrick & Harvey Machine Co., Baltimore, Md. Cable: Detharvey.
Fischer Machine Co., Philadelphia, Penn.
Garvin Mach. Co., Spring and Varick St., N. Y. C.
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.
Pratt & Whitney Co., Hartford, Conn.
Stark Tool Co., Waltham, Mass.

Pulley Turning and Boring Machines
American Tool Works Co., Cincinnati, Ohio.
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.

Pulley, Cork Insert
American Pulley Co., 29th and Bristol, Phila., Pa. 33 Greene St., N. Y. City; 124 S. Clinton St., Chicago; 165 Pearl St., Boston; 536 First Ave., S., Seattle. Cable: Amerpulley.

Pulleys, Metal
American Pulley Co., 29th and Bristol, Phila., Pa.; 33 Greene St., N. Y. City; 124 S. Clinton St., Chicago; 165 Pearl St., Boston; 536 First Ave., S., Seattle. Cable: Amerpulley. Sizes 3" to 120" diameter.
American Tool Works Co., The, Cincinnati, Ohio. Steel split pulleys. Put on shaft by means of interchangeable bushings. Grooved face belt contact.
Brown Co., A. & F., 79 Barclay St., N. Y. City.
Link-Belt Co., 39th St. and Stewart Ave., Chicago. Philadelphia and Indianapolis.
Reliance Gauge Column Co., 6009 Carnegie Ave., Cleveland, Ohio.
Wilmarth & Morman Co., 1187 Monroe Ave., Grand Rapids, Mich.

Pulleys, Paper
Rockwood Mfg. Co., The, Indianapolis, Ind.

Pumps, Hydraulic
Elmes Eng. Works, Chas. F., 1001 Fulton St., Chicago, Ill.
International Steam Pump Co., 115 Bway., N. Y. C.
Watson-Stillman Co., 42 Church St., N. Y. City.

Pumps, Lubricant
Cincinnati Lubricant Pump Co., Cincinnati, Ohio. Fulflo lubricant pump. Centrifugal pump requiring no check valves, relief valves or strainers. Deliver 15 gal. per min. with a 3¼-inch stream.
International Steam Pump Co., 115 Bway., N. Y. C.
Richardson-Phenix Co., 119 Reservoir Ave., Milwaukee, Wis.

Pumps, Pneumatic and Steam
Ingersoll-Rand Co., 11 Broadway, New York City.
International Steam Pump Co., 115 Bway., N. Y. C.
Southwark Fdry. & Mach. Co., Philadelphia, Pa.

Punches, Center
Hammacher, Schlemmer & Co., 13th St. and 4th Ave., New York City.
Starrett Co., L. S., Athol, Mass.

Punches, Hydraulic
Elmes Eng. Wks., Chas. F., 1001 Fulton St., Chicago, Ill.
Watson-Stillman Co., 42 Church St., N. Y. City.

Punches, Power
Armstrong-Blum Mfg. Co., Chicago, Ill.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Covington Machine Co., Covington, Va.
Ferracute Machine Co., Bridgeton, N. J.
Long & Allstatter Co., Hamilton, Ohio.
Mitts & Merrill, 913 Tilden St., Saginaw, Mich.
Prentiss Tool & Supply Co., Singer Bldg., N. Y. C.
Royersford Fdry. & Mach. Co., Royersford, Penn.
Union Mfg. Co., New Britain, Conn.

Pyrometers, Electric
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Penn.

Rack Cutting Machines
Gould & Eberhardt, Newark, N. J. Light type, 36"x6" and 72"x10". Heavy type, 6'x12", 8'x12", 10'x12".
LeBlond Machine Tool Co., R. K., Cincinnati, O.

Racks, Cut
Boston Gear Works, Norfolk Downs, Mass.
Fawcus Machine Co., Pittsburgh, Penn.
Grant Gear Works, Inc., 151 Pearl St., Boston.
Horsburgh & Scott Co., Cleveland, Ohio.
Meisel Press Mfg. Co., 946 Dor. Ave., Boston.
Newark Gear Cutting Machine Co., Newark, N. J.
New Britain Machine Co., New Britain, Conn.
New England Gear Works, 100 Purchase, Boston.
Nuttall Co., R. D., Pittsburgh, Penn.
Philadelphia Gear Works, Vine St. and Reading R.R., Philadelphia, Penn.
Van Dorn & Dutton Co., Cleveland, Ohio.

Racks, Storage **(See Furniture, Machine Shop)**

Radiators, Japanning Oven
American Gas Furnace Co., 24 John St., N. Y. C.

Rammers, Foundry
Ingersoll-Rand Co., 11 Broadway, New York City.

Reamer Holders
Colburn Mach. Tool Co., Franklin, Penn.

Reamers, Expanding
Cleveland Twist Drill Co., Cleveland, Ohio.
Detroit Twist Drill Co., 644 Fort St., Detroit.
Pratt & Whitney Co., Hartford, Conn.
Whitman & Barnes Mfg. Co., Akron, Ohio.

Reamers, Solid
Brubaker & Bros., W. L., Millersburg, Penn.
Butterfield & Co., Derby Line, Vt.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Celfor Tool Co., Buchanan, Mich.
Cleveland Twist Drill Co., E. 49th St. and Lakeside Ave., Cleveland, Ohio. New York, 30 Reade St.; Chicago, 9 N. Jefferson St. Reamers of all sizes and types.
Detroit Twist Drill Co., 644 Fort St., Detroit.
Greenfield Tap & Die Corp., Greenfield, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
National Twist Drill & Tool Co., Detroit, Mich.
Pratt & Whitney Co., Hartford, Conn.
Reed Mfg. Co., Erie, Penn.
Standard Tool Co., Cleveland, Ohio.
Union Twist Drill Co., Athol, Mass.
Wells & Son Co., F. E., Greenfield, Mass.
Western Tool & Mfg. Co., Springfield, Ohio.
Whitman & Barnes Mfg. Co., Akron, Ohio.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Recorders, Pressure
Bristol Co., Waterbury, Conn.

Recorders, Time
Bristol Co., Waterbury, Conn.
Calculagraph Co., 1438 Jewelers Bldg., N. Y. C.

Rheostats
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.

Rivet Making Machinery
National Machinery Co., Tiffin, Ohio.

Riveters, Hydraulic, Pneumatic and Steam
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Independent Pneumatic Tool Co., Thor Bldg., Chicago, Ill.
Ingersoll-Rand Co., 11 Broadway, New York City.
Southwark Fdry. & Mach. Co., Philadelphia, Pa.

Riveting Machines
Adt & Son, John, New Haven, Conn.
Grant Mfg. & Machine Co., 85 Silliman Ave., Bridgeport, Conn.
Long & Allstatter Co., Hamilton, Ohio.
Shuster Co., The F. B., New Haven, Conn.
Toledo Electric Welder Co., 4100 Langland St., Cincinnati, Ohio. Cable: Tolcin, Cincinnati. Riveting by electric welding process.
Townsend Mfg. Co., H. P., Hartford, Conn.

Rules, Steel
Hammacher, Schlemmer & Co., 13th St. and 4th Ave., New York City.
Starrett Co., L. S., Athol, Mass.

Rust Preventives
Houghton & Co., E. F., 240 W. Somerset St., Philadelphia, Penn.

Safety Devices, Press
Benjamin Elec. Mfg. Co., 120 Sangamon St., Chicago, Ill.
Geuder, Paeschke & Frey Co., 1301 St. Paul Ave., Milwaukee, Wis.

Sand-Blast Apparatus
Betton, J. M., 26 Park Place, New York City.
Mott Sand Blast Co., 1157 E. 138th St., N. Y. C.
Paxson Co., J. W., 1021 N. Delaware Ave., Philadelphia, Penn.

Sand-Sifting Machinery
Link-Belt Co., 39th St. and Stewart Ave., Chicago. Philadelphia and Indianapolis.

Safety Devices, Press
Safety Engineering Co., 1440 Schoffield St., Cleveland, Ohio.

Saw Frames and Blades, Hack
Atkins Co., E. C., Indianapolis, Ind.
Diamond Saw & Stamping Wks., Buffalo, N. Y. Trade-mark "Sterling." 8" to 36" blades.
Disston & Sons, Inc., Henry, Philadelphia, Penn.
Hammacher, Schlemmer & Co., 13th St. and 4th Ave., New York City.
Millers Falls Co., Millers Falls, Mass.
Quality Saw & Tool Works, Springfield, Mass.
Racine Tool & Machine Co., 1400 Jones Ave., Racine, Wis.
Simonds Mfg. Co., Fitchburg, Mass. New York, Chicago, Montreal, Memphis, New Orleans, San Francisco, Portland, Seattle, Vancouver, St. Johns.
Smith & Hemanway Co., 150 Chambers St., N. Y.
Starrett Co., L. S., Athol, Mass.
Thompson & Son Co., Hy. G., New Haven, Conn.
West Haven Mfg. Co., New Haven, Conn.

Sawing Machines, Metal
Atkins Co., E. C., Indianapolis, Ind.
Armstrong-Blum Mfg. Co., 347 N. Francisco Ave., Chicago, Ill.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Diamond Saw & Stamping Wks., Buffalo, N. Y. Trade-mark "Sterling." Capacity 5x5" to 8x12".
Earle Gear & Machine Co., 101 E. Wyoming Ave., Philadelphia, Penn.
Gorton Machine Co., Geo., Racine, Wis.
Hoefer Mfg. Co., Freeport, Ill.
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.
Nutter & Barnes Co., Hinsdale, N. H.
Peerless Machine Co., 1615 Racine St., Racine, Wis.
Quality Saw & Tool Works, Springfield, Mass.
Racine Tool & Machine Co., 1400 Jones Ave., Racine, Wis. Four sizes, 6"x6", 8"x8", 12"x12", 12"x15".
Sellew Machine Tool Co., Pawtucket, R. I.
Union Twist Drill Co., Athol, Mass.

"The only machine for counting duplicate parts on the market capable of doing business and doing it all the time."

A Buffalo manufacturer said this when ordering additional equipment for his London, England Branch. That this is not an isolated opinion is proven by the fact that thousands of

National Counting and Weighing Machines

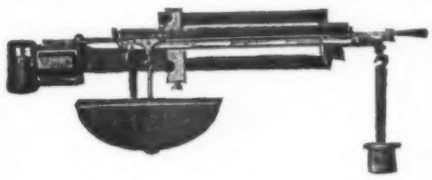
are in use in every conceivable line of manufacturing—saving money every day.

This machine counts faster and more accurately than any other known method of mental or machine counting. It is practically automatic, requiring only two simple manual operations.

Let the National Counting Machine solve *your* counting problems and save you money.

Send for Illustrated Catalog B.

National Scale Company
Montgomery Street Chicopee Falls, Mass.
Manufacturers of National-Chapman Elevating Trucks

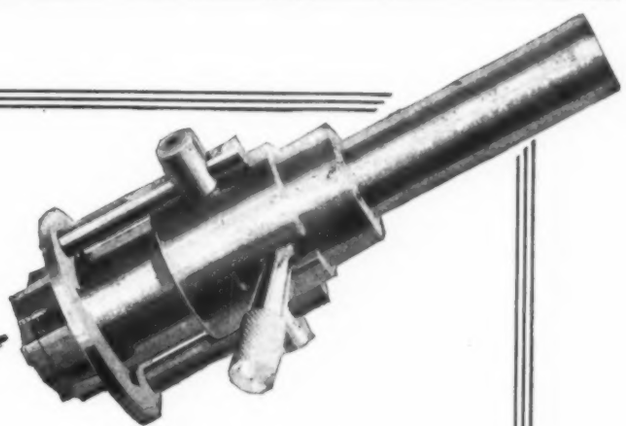


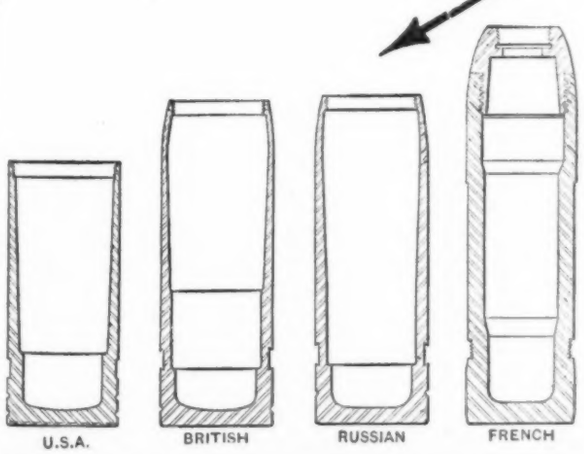
Put a few parts in the ratio container—figures on the beam tell you how many. Balance the container and you immediately have the correct total count of parts in the scoop—this model will count up to 6,400¼ oz. parts.

Correct Balance Gives Correct Count

RUSSIAN SHELLS

Large quantities of Russian Shells bear the workmanship of Murchey Collapsing Taps. If you are making Russian, or other shells, it will pay you to investigate the Murchey.





MURCHEY COLLAPSING TAPS

are simple, accurate and durable. They have fewer parts than others and are making big economy records on shell work. Shell makers everywhere can tell you about Murchey Collapsing Taps and Automatic Self-Opening Dies—**they are using them.**

Write for Catalog.

Murchey Machine & Tool Co.
64 Porter Street, Detroit, Mich.

The Coats Machine Tool Co., 34 Victoria St., London, England. Fenwick, Freres & Co., 15 Rue Fenelon, Paris, France.

Vandyck Churchill Co., 93 Liberty St., N. Y. C.
West Haven Mfg. Co., New Haven, Conn.

Sawing Machines, Power Hack
Atkins Co., E. C., Indianapolis, Ind.
Diamond Saw & Stamping Wks., Buffalo, N. Y. Trade-mark "Sterling." Capacity 5x5" to 8x12".
Millers Falls Mfg. Co., Millers Falls, Mass.
Peerless Machine Co., 1615 Racine St., Racine, Wis.
Quality Saw & Tool Works, Springfield, Mass.
Racine Tool & Machine Co., 1400 Jones Ave., Racine, Wis.
Thompson & Son Co., Hy. G., New Haven, Conn.
Western Tool & Mfg. Co., Springfield, Ohio.
West Haven Mfg. Co., New Haven, Conn.

Saw Sharpening Machines
Disston & Sons, Inc., Henry, Philadelphia, Penn.
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.
Nutter & Barnes Co., Hinsdale, N. H.

Saws, Circular Metal
Atkins Co., E. C., Indianapolis, Ind.
Barber-Colman Co., Rockford, Ill.
Disston & Sons, Inc., Henry, Philadelphia, Penn.
Huther Bros. Saw Mfg. Co., Rochester, N. Y.
Pratt & Whitney Co., Hartford, Conn.
Quality Saw & Tool Works, Springfield, Mass.
Seneca Falls Mfg. Co., 687 Water St., Seneca Falls, N. Y.
Simonds Mfg. Co., Fitchburg, Mass. New York, Chicago, Montreal, Memphis, New Orleans, San Francisco, Portland, Seattle, Vancouver, St. Johns.
Union Twist Drill Co., Athol, Mass.
West Haven Mfg. Co., New Haven, Conn.

Saws, Metal Band
Atkins Co., C. E., Indianapolis, Ind.
Disston & Sons, Inc., Henry, Philadelphia, Penn.
Garvin Mach. Co., Spring and Varick St., N. Y. C.
Greaves, Klusman Tool Co., Cincinnati, Ohio.
Quality Saw & Tool Works, Springfield, Mass.
Racine Tool & Machine Co., 1400 Jones Ave., Racine, Wis.
Simonds Mfg. Co., Fitchburg, Mass. New York, Chicago, Montreal, Memphis, New Orleans, San Francisco, Portland, Seattle, Vancouver, St. Johns.
West Haven Mfg. Co., New Haven, Conn.

Saws, Screw Slotting
Atkins Co., E. C., Indianapolis, Ind.
Barber-Colman Co., Rockford, Ill.
Disston & Sons, Inc., Henry, Philadelphia, Penn.
Pratt & Whitney Co., Hartford, Conn.
Reed & Prince Mfg. Co., Worcester, Mass.
Simonds Mfg. Co., Fitchburg, Mass. New York, Chicago, Montreal, Memphis, New Orleans, San Francisco, Portland, Seattle, Vancouver, St. Johns.
Union Twist Drill Co., Athol, Mass.

Saw Tables, Universal
Colburn Machine Tool Co., Franklin, Penn.

Scales
National Scale Co., Montgomery St., Chicopee Falls, Mass.

Screw Drivers
Neil & Smith Electric Tool Co., Cincinnati, Ohio.
Page-Storms Drop Forge Co., Chicopee, Mass.

Screw Driving Machines, Automatic
Reynolds Pattern & Machine Co., Moline, Ill.

Screw-Machine Work
Ball & Roller Bearing Co., Danbury, Conn.
Barnes Co., The Wallace, 38 Wallace St., Bristol, Conn.
Cincinnati Automatic Machine Co., Oakley, Cincinnati, Ohio.
Cincinnati Screw Co., Twightwee, Ohio.
Eastern Machine Screw Corp., New Haven, Conn.
National Acme Mfg. Co., Cleveland, Ohio.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Worcester Machine Screw Co., Worcester, Mass.

Screw Machinery, Wood and Lag
Cook Co., Asa S., Hartford, Conn.
Townsend Mfg. Co., H. P., Hartford, Conn.

Screw Machines, Automatic
Brown & Sharpe Mfg. Co., Providence, R. I.
3 sizes. Both cone and constant speed drives. Nos. 00 and 00G—Stock to $\frac{5}{16}$"; turn to 1¼"; feed 2". Nos. 0 and 0G—Stock to ½"; turn 1¾"; feed 3". Nos. 2 and 2G—Stock to ⅞"; turn 2"½; feed 4".
For branches and agents see our advertisement.
Cincinnati Automatic Machine Co., Oakley, Cincinnati. Cable: Hayden.
Sizes ¾x3" and 1½x5". Five spindles, single-belt drive, index plates on machine. Each of 9 tools has its own cam. Starting and stopping lever on each side of machine.
Agents: Prentiss Tool & Supply Co., New York; Motch & Merryweather, Cleveland, Detroit and Pittsburgh; Marshall & Huschart Machy. Co., Chicago, St. Louis, Indianapolis; W. E. Shipley Machy. Co., Philadelphia.
Cleveland Automatic Machine Co., 2269 Ashland Rd., Cleveland, Ohio. Cable: "Clyne."
Sizes made—¼, ⅜, ½, ⅝, ¾, ⅞, 1, 1⅛, 1¼, 1½, 2¼, 2½, 2¾, 3¼, 4, 4¼, 5½, 6¾, 7¾. Produce pieces from bar of $\frac{3}{32}$" to 7¾" diameter up to 18" long.
Full automatic machines.
Agents: (Foreign) Chas. Churchill & Co., 9-15 Leonard St., London, Birmingham and Manchester, England, and also Glasgow, Scotland. (Domestic) J. B. Anderson, 211 Mt. Gowen Ave., Philadelphia, Pa.; H. E. Nunn, 565 West Washington St., Chicago, Ill.
Davenport Machine Tool Co., New Bedford, Mass.
One size—½" diameter and turns 2" long.
National-Acme Manufacturing Co., The, 7500 Stanton Ave., Cleveland, Ohio. Branches: New York, Chicago, Boston, Detroit and Montreal.
Capacities—From smallest up to 2¼" diameter to 10½" long.
The "Acme" automatic four-spindle screw machine, eight tool positions, simultaneous tool cutting, piece completed in the time of the longest operation, single belt or motor equipment.
Agents: C. W. Burton, Griffiths & Co. for Great Britain; Benson Bros. at Sidney for Australia; Schuchardt & Schutte for Germany.
New Britain Machine Co., New Britain, Conn. 2008 W. Grand Blvd., Detroit, Mich.
Six spindles. Four sizes—⅝"x3¾", 1"x5", 1⅝"x7", 2½"x9".
Agents: Coats Machine Tool Co., Ltd., Caxton House, London.
Townsend Mfg. Co., H. P., Hartford, Conn.
Windsor Machine Co., Windsor, Vt., U. S. A. Cable: "Machine," Windsor, Vt.
Gridley multiple-spindle automatics. 3 sizes: 3¼"x4½", 1¼"x5½" and 2¼"x7". Hold four bars of stock in the spindle-carrying cylinder, which revolves step by step bringing each spindle with its bar successively into alignment with each tool. The tool slide upon which the tools are mounted and whose axis is concentric with that of the cylinder does not revolve, but through its automatically controlled longitudinal movement it feeds the tools to the work.
Gridley single-spindle automatics. 3 sizes, handling bars not larger than 2¼", 3¼" and 4¼" in diameter. Have only one spindle, which revolves without change of position, while the turret with the attached slides on which the tools are mounted is revolved step by step on a horizontal axis, bringing each slide with its tools into working position, and by the movement of the individual turret tool slides the tools are brought into contact with the work.

Screw Machines, Hand
Acme Machine Tool Co., Cincinnati, Ohio. Cable: Acme.
Five sizes. Automatic chuck capacity ⅝" to 2¼", 11" to 20" swing. Plain or friction geared head with or without automatic feed to turret.
Dreses Machine Tool Co., 227-241 W. McMicken Ave., Cincinnati, O. Cable Address: Dreses.
Sizes—1", 1½" and 2¼" stock.
Plain, friction back geared, belt and motor driven.
Foster Machine Co., Elkhart, Ind.
Garvin Mach. Co., Spring and Varick St., N. Y. C.
Jones & Lamson Machine Co., Springfield, Vt., U. S. A. Cable Address: Turret. Branch: Jones & Lamson Machine Co., 97 Queen Victoria St., London, E. C., England. Cable: Turretorum.
Sizes made: 2½" and 3". Capacities: for bar stock up to 2¼" diameter by 24" long, and up to 3" diameter by 36" long, respectively.
Has flat turret and universal tool outfit. Duplicate lathe work made from the bar, in large quantities or small. Also sold with chucking outfit.
Agents: Germany, Switzerland, Austria-Hungary, M. Koyemann, Charlottenstrasse 112, Dusseldorf, Germany; France, Spain and Belgium, F. Auberty & Co., 91 Rue de Maubeuge, Paris.
Oliver Machinery Co., Grand Rapids, Mich.
Pratt & Whitney Co., Hartford, Conn.
Warner & Swasey Co., Cleveland, Ohio.
Wells & Son Co., F. E., Greenfield, Mass.
Windsor Machine Co., Windsor, Vt.

Screw Machines, Plain or Hand
Brown & Sharpe Mfg. Co., Providence, R. I.
Wire feed. 5 sizes. Take stock from $\frac{3}{32}$" to 1½"; turning length 2¼" to 10". Both automatic feed and roller feed type.
Plain. 2 sizes, 1½"x8" and 1⅝"x10". Cone drive. Powerful friction back gears. Swing over bed 15¼" and 18". Swing over cross slide 7¾" and 8¾". Eight changes of feed for turret for each spindle speed. Twelve changes of spindle speed direct. Six reverse.
For branches and agents see our advertisement.

Screw Plates
Bay State Tap & Die Co., Mansfield, Mass.
Brubaker & Bros., W. L., Millersburg, Pa. New York, Chicago, Pittsburgh, San Francisco.
Butterfield & Co., Derby Line, Vt.
Card Mfg. Co., S. W., Mansfield, Mass. Cable: Card, Mansfield. N. Y. Office: 62 Reade St.
All sizes in machine screw and fractional in V, U. S. standard, Whitworth, International and French standards (metric system), B. A. standard, S. A. E. standard, A. S. M. E. standard.
Automobile, bicycle, blacksmiths', diamond favorite, gunsmith, improved machinists', motorcycle, paragon, watchmakers'.
Screw plate stocks: Diamond, Favorite, Improved Machinists', Paragon.
Berlin store, Arthur Kayser, Mgr., Alte Jacobstrasse, 24. Chas. Churchill & Co., London, Birmingham, Manchester and Glasgow. Markel & Co., Paris. Fenwick Freres & Co., Turin. Ignacz Szekely, Budapest. V. Lowener, Stockholm, Copenhagen. A. A. Kampfraath (Brussels), Ltd., Brussels. Hans Schulze, Vienna and Brum, Austria. Andrews & George, Yokohoma, Tokyo, Osaka. J. Lambercier & Co., Geneva.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Greenfield Tap & Die Corp., Greenfield, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Wells & Son Co., F. E., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Screws, Cap and Set
Allen Mfg. Co., 135 Sheldon St., Hartford, Conn.
Bristol Co., Waterbury, Conn.
Cincinnati Screw Co., Twightwee, Ohio.
Hammacher, Schlemmer & Co., 13th St. and 4th Ave., New York City.
Progressive Mfg. Co., Torrington, Conn.
Worcester Machine Screw Co., Worcester, Mass.

Screws, Machine
Allen Mfg. Co., 135 Sheldon St., Hartford, Conn.
Bristol Co., Waterbury, Conn.
Brown Bag Filling Machine Co., Fitchburg, Mass.
Cincinnati Automatic Machine Co., Oakley, Cincinnati.
Brown & Sharpe Mfg. Co., Providence, R. I.
Hammacher, Schlemmer & Co., 13th St. and 4th Ave., New York City.
Jones & Lamson Machine Co., Springfield, Vt.
Progressive Mfg. Co., Torrington, Conn.
Worcester Machine Screw Co., Worcester, Mass.

Screws, Safety Set
Allen Mfg. Co., 135 Sheldon St., Hartford, Conn.
Bristol Co., Waterbury, Conn.
Hammacher, Schlemmer & Co., 13th St. and 4th Ave., New York City.
Progressive Mfg .Co., Torrington, Conn.
Standard Pressed Steel Co., Philadelphia, Penn.

Second-Hand Machinery
Garvin Mach. Co., Spring and Varick St., N. Y. C.
Hill, Clarke & Co., Inc., 156 Oliver St., Boston.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.
Prentiss Tool & Supply Co., Singer Bldg., N. Y. C.
Simmonds Mach. Co., Inc., 985 Broadway, Albany, N. Y.
Strong, Carlisle, Hammond Co., Cleveland, Ohio.
Toomey, Inc., Frank, Philadelphia, Penn.

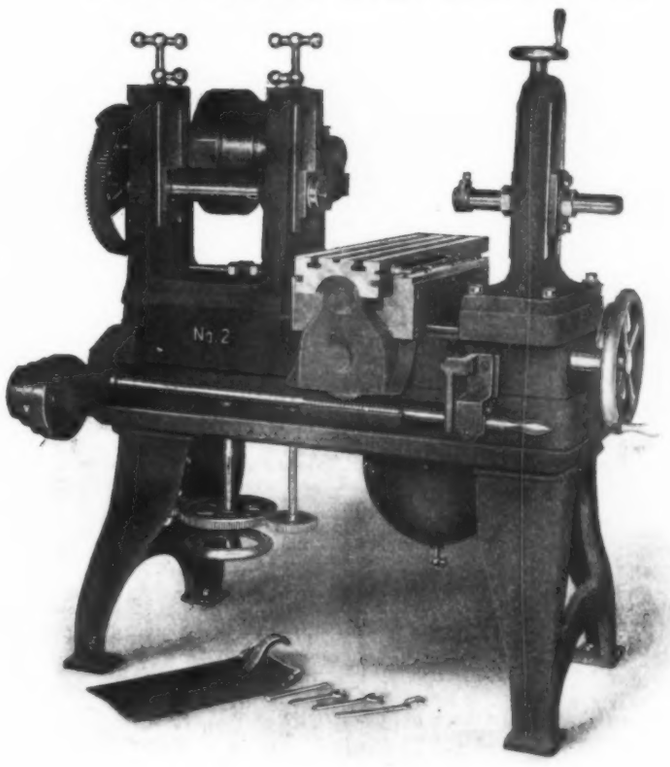
Separators, Oil and Waste
Oil & Waste Saving Mach. Co., Real Estate Trust Bldg., Philadelphia, Penn.

Separators, Steam
Nicholson Co., W. H., 114 Oregon St., Wilkes-Barre, Penn.

Shafts, Crank and Jack
New Process Gear Corporation, Syracuse, N. Y. Automobile jack shafts.
Standard Gauge Steel Co., Beaver Falls, Penn.

Shaping Machines
American Tool Works Co., The, Cincinnati, U. S. A. Cable: "Lathe, Cincinnati."
Sizes 15, 16, 20, 24, 28 inches stroke. 15" shapers are single geared, all other sizes are back geared. Four types: Cone drive, geared speed box for belt and motor drive and direct connected variable speed motor drive without speed box.
Special equipment for mould work and for tool-room requirements for all sizes.
See our advertisement on pages 14 and 15.
Cincinnati Shaper Co., Cincinnati, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
Gould & Eberhardt, Newark, N. J.
Seven sizes: 14", 16", 20", 28", 32". For spiral gears—4 sizes: 12", 18", 36", 72".
Hendey Machine Co., Torrington, Conn. Cable "Hendey." Branches: Boston, N. Y., Chicago.
Sizes—15, 20, 24 and 28" stroke.
Friction clutch driven, having double gear drive to double rack in ram. Speed of ram constant whether running long or short stroke; length and position of stroke of ram easily changed while machine is in motion. 15" and 20" shapers furnished with adjustable table only; 24" and 28" stroke machines furnished with both solid and adjustable table as desired, also regularly equipped with power down feed.
Agents: Pacific Tool & Supply Co., San Francisco; Colcord-Wright Mchy. & Supply Co., St. Louis; W. M. Pattison Supply Co., Cleveland, Detroit; Syracuse Supply Co., Syracuse, Buffalo; Sherritt & Stoer Co., Phila.; Laughlin-Barney Mchy. Co., Pittsburgh; A. R. Williams Mchy. Co., Toronto, Winnipeg, St. John and Vancouver; Williams & Wilson, Ltd., Montreal; Chas. Churchill & Co., Ltd., London.
Kelly Co., R. A., P. O. Box 488, Xenia, Ohio.
Morton Mfg. Co., Muskegon Heights, Mich.
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.
Ohio Machine Tool Co., Leighton St., Kenton, O.
Potter & Johnston, Pawtucket, R. I. Cable: Arran, Pawtucket.
15"-24" stroke.
Prentiss Tool & Supply Co., Singer Bldg., N. Y. C.
Smith & Mills Co., Cincinnati, Ohio.
Springfield Mach. & Tool Co., Springfield, Ohio. Cable: Montanus. 12", 15" and 20" crank. 16", 20" and 25" back geared.
Steptoe Co., The John, Northside, Cincinnati, O.
Strong, Carlisle, Hammond Co., Cleveland, Ohio.

Thirty (30) Garvin
No. 2 Lincoln Milling Machines
AVAILABLE



GARVIN No. 2 Lincoln Milling Machine

THIS is a powerful machine and has a generous oil pan and reservoir and a large range of adjustment. The spindle has large bearings in adjustable boxes and is driven by a large cone and wide belt. The table is wide and deep and provided with two T slots $\frac{3}{4}$ inch wide and center groove. The feed works are thoroughly protected and the feed belt runs at high speed and is provided with an efficient swing tightener. The saddle has screw adjustment and positive screw stops. The tail stock is of the most solid description and the tail block is firmly clamped and adjusted by hand wheel above. The tail spindle is adjusted by large nuts and the arbor bearing is a hardened steel bushing, adjustable for wear and provided with special oil facilities.

General Dimensions

Dimensions of table	$7\frac{1}{2}$ x $28\frac{1}{4}$ in.
Adjustment of spindle above table	$2\frac{1}{2}$ x $9\frac{1}{4}$ in.
Adjustment in line with spindle	7 in.
Length of automatic feed of table	$21\frac{1}{2}$ in.
Maximum distance between head and tail stock	20 in.
Number of feed changes	4
Domestic shipment crated, weight	1900 lbs.

30 unsold in lot going through. Part delivery this month, complete delivery by January.

FOR FURTHER INFORMATION { ASK YOUR DEALER / OR WRITE US DIRECT

MANUFACTURED BY VISITORS WELCOME

THE GARVIN MACHINE COMPANY

Spring and Varick Streets 50 Years in New York City

Shapes, Cold-Drawn Steel
Union Drawn Steel Co., Beaver Falls, Penn.

Shears, Hand
Armstrong-Blum Mfg. Co., 347 N. Francisco Ave., Chicago, Ill.
Chicago Patented Tool Co., 1605 Owen Ave., Racine, Wis.
Oliver Mfg. Co., W. W., Buffalo, N. Y. Cable: Oliver, Buffalo.

Shears, Power
Bethlehem Steel Co., Machinery Dept., South Bethlehem, Penn.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Covington Machine Co., Covington, Va.
Ferracute Machine Co., Bridgeton, N. J.
Groos Co., 16th and Owen Ave., Racine, Wis.
Long & Allstatter Co., Hamilton, Ohio.
Mitts & Merrill, 913 Tilden St., Saginaw, Mich.
Niagara Mach. & Tool Works, Buffalo, N. Y.
Royersford Fdry. & Mach. Co., Royersford, Penn.
Toledo Machine & Tool Co., Toledo, Ohio.
Union Mfg. Co., New Britain, Conn.

Sheet Metal Working Machinery
Ferracute Machine Co., Bridgeton, N. J.
Niagara Mach. & Tool Works, Buffalo, N. Y.
Savage Co., Inc., W. J., Knoxville, Tenn.
For cutting sheet metal and plates in any conceivable shape without springing or buckling material. Capacity up to $\frac{3}{16}$" inclusive.
Toledo Machine & Tool Co., Toledo, Ohio.

Shelving, Steel (See Furniture, Machine Shop)

Slide Rests
Reed-Prentice Co., Worcester, Mass.

Slotting Machines
Armstrong Bros. Tool Co., 315 N. Francisco Ave., Chicago, Ill.
Baker Bros., Toledo, Ohio.
Garvin Mach. Co., Spring and Varick St., N. Y. C.
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.
Niles-Bement-Pond Co., 111 Broadway, N. Y. C.

Soap, Hand
White & Bagley Co., Worcester, Mass.
"Cleanzum."

Sockets and Sleeves
Cleveland Twist Drill Co., E. 49th St. and Lakeside Ave., Cleveland, Ohio. New York, 30 Reade St.; Chicago, 9 N. Jefferson St.
Detroit Twist Drill Co., 644 Fort St., Detroit.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, Ohio.
Union Twist Drill Co., Athol, Mass.
Whitman & Barnes Mfg. Co., Akron, Ohio.

Spraying Machines
Spray Engineering Co., 91 Federal St., Boston.

Special Machinery and Tools
American Machine & Fdry. Co., 353 Carroll St., Brooklyn, N. Y. New York Office: 200 5th Ave.
Bilgram Machine Works, 1233 Spring Garden St., Philadelphia, Penn.
Blanchard Machine Co., 64 State St., Cambridge, Mass.
Cambridge Machine Co., Cambridge, Ohio.
Clark Flexible Coupling Co., 27 Walker St., N. Y.
Columbus Die Tool & Mach. Co., Columbus, Ohio.
Cowdrey Mach. Wks., C. H., Fitchburg, Mass.
Earle Gear & Machine Co., 101 E. Wyoming Ave., Philadelphia, Penn.
Ensign Mfg. Co., Brighton, Boston, Mass.
Fawcus Machine Co., Pittsburgh, Penn.
Foster Machine Co., Elkhart, Ind.
Garvin Mach. Co., Spring and Varick St., N. Y. C.
Gem City Machine Co., Dayton, Ohio.
Harris Engineering Co., H. E., Bridgeport, Conn.
Hartford Special Machinery Co., 734 Main St., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Hoefer Mfg. Co., Freeport, Ill.
Holyoke Machine Co., Worcester, Mass.
International Oxygen Co., 115 Broadway, N. Y.
Mailometer Co., Detroit, Mich.
Marvin & Casler Co., Canastota, N. Y.
Meisel Press Mfg. Co., 946 Dor. Ave., Boston.
Modern Tool Die & Mach. Co., Columbus, Ohio.
Mulliner-Enlund Co., 541 S. Clinton St., Syracuse, N. Y.
Nazel Engineering & Machine Works, 4041 N. 5th St., Philadelphia, Penn.
Newton Machine Tool Works, 23rd and Vine St., Philadelphia, Penn.
Oxweld Acetylene Co., Chicago, Ill.
Peerless Machine Co., 1615 Racine St., Racine, Wis.
Reynolds Pattern & Machine Co., Moline, Ill.
Rickert-Shafer Co., Erie, Penn.
Rowbottom Machine Co., Waterbury, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Stanley Co., 48 Loring Ave., Salem, Mass.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Underwood & Co., H. B., 1026 Hamilton St., Philadelphia, Penn.
Union Twist Drill Co., Athol, Mass.
Waltham Machine Wks., High St., Waltham, Mass.

Springs
Barnes Co., Wallace, 38 Wallace St., Bristol, Conn.

Sprockets and Chains
American Chain Co., Bridgeport, Conn.
Baldwin Chain & Mfg. Co., Worcester, Mass.
All American sizes both roller and block.
Bilgram Machine Works, 1233 Spring Garden St., Philadelphia, Penn.
Boston Gear Works, Norfolk Downs, Mass.
Caldwell & Son Co., H. W., 17th St. and Western Ave., Chicago, Ill.
Grant Gear Works, Inc., 151 Pearl St., Boston.
Link-Belt Co., 39th St. and Stewart Ave., Chicago, Ill. Philadelphia and Indianapolis.
Morse Chain Co., Ithaca, N. Y.
Philadelphia Gear Works, Vine St. and Reading R.R., Philadelphia, Penn.

Stampings, Metal
Bay State Stamping Co., Worcester, Mass.
Gem Mfg. Co., 3257 Spruce St., Pittsburgh, Penn.
Geuder, Paeschke & Frey Co., 1301 St. Paul Ave., Milwaukee, Wis.
Standard Welding Co., Cleveland, Ohio.

Kales-Haskel Co., Detroit, Mich.
New Britain Machine Co., New Britain, Conn.
Stamping welded.

Stamps, Steel
Hoggson & Pettis Mfg. Co, New Haven, Conn.

Stands, Portable (See Furniture, Machine Shop)

Steam Specialties
Dart Mfg. Co., E. M., Providence, R. I.
Reliance Gauge Column Co., 6009 Carnegie Ave., Cleveland, Ohio.
Richardson-Phenix Co., 119 Reservoir Ave., Milwaukee, Wis.

Steel Hardness Measuring Instruments
Shore Instrument & Mfg. Co., 555 W. 22nd St., New York City. "Sceleroscope."

Steel Heat Testing Instruments
Shore Instrument & Mfg. Co., 555 W. 22nd St., New York. "Pyroscope."

Steel, Sheet
Hobson, Houghton & Co., 83 Beekman, N. Y. C.
Jessop & Sons, Inc., Wm., 91 John St., N. Y. C.
Union Drawn Steel Co., Beaver Falls, Penn.
Ward's Sons, Edgar T., 25 Purchase St., Boston.

Steels, Alloy
Firth-Sterling Steel Co., McKeesport, Penn.
Halcomb Steel Co., Syracuse, N. Y.
Hawkridge Bros. Co., 303 Congress St., Boston.
Vulcan Crucible Steel Co., Aliquippa, Penn.

Steels, Carbon Tool
Armstrong Bros. Tool Co., 315 N. Francisco Ave., Chicago, Ill.
Cleveland Twist Drill Co., E. 49th St. and Lakeside Ave., Cleveland, Ohio. New York, 30 Reade St.; Chicago, 9 N. Jefferson St.
Disston & Sons, Inc., Henry, Philadelphia, Penn.
Firth-Sterling Steel Co., McKeesport, Penn.
Halcomb Steel Co., Syracuse, N. Y. Branches: Chicago, Cleveland, Philadelphia, New York. Trade-mark "Ketos."
Hawkridge Bros. Co., 303 Congress St., Boston.
Hobson, Houghton & Co., 83 Beekman St., N. Y. C.
Jessop & Sons, Inc., Wm., 91 John St., N. Y. C.
Swedish Iron & Steel Co., 12 Platt St., N. Y. C.
Union Drawn Steel Co., Beaver Falls, Penn.
Vulcan Crucible Steel Co., Aliquippa, Penn.
Ward's Sons, Edgar T., 25 Purchase St., Boston.
Western Tool & Mfg. Co., Springfield, Ohio.

Steels, Chrome
Firth-Sterling Co., McKeesport, Penn.
Halcomb Steel Co., Syracuse, N. Y.
Hawkridge Bros. Co., 303 Congress St., Boston.
Jessop & Sons, Inc., Wm., 91 John St., N. Y. C.
Vanadium Alloys Steel Co., Pittsburgh, Penn.
Vulcan Crucible Steel Co., Aliquippa, Penn.
Williams Co., J. H., 35 Richards St., Brooklyn.

Steels, High-Speed
Armstrong Bros. Tool Co., 315 N. Francisco Ave., Chicago, Ill.
Hobson, Houghton & Co., 83 Beekman St., N. Y. C.
Cleveland Twist Drill Co., E. 49th St. and Lakeside Ave., Cleveland, Ohio. New York, 30 Reade St.; Chicago, 9 N. Jefferson St.
Disston & Sons, Inc., Henry, Philadelphia, Penn.
Firth-Sterling Steel Co., McKeesport, Penn.
Halcomb Steel Co., Syracuse, N. Y. Branches: Chicago, Cleveland, Philadelphia, New York. Trade-mark "Dreadnought."
Hawkridge Bros. Co., 303 Congress St., Boston.
Hobson, Houghton & Co., 83 Beekman St., N. Y. C.
Vulcan Crucible Steel Co., Aliquippa, Penn.
"Vulcan-Cobalt" for turning shells.
Ward's Sons, Edgar T., 25 Purchase St., Boston.
Williams Co., J. H., 35 Richards St., Brooklyn.

Stocks, Die (See Taps and Dies)

Stools, Shop
Manufacturing Equipment & Engineering Co., 209 Washington St., Boston, Mass.
New Britain Machine Co., New Britain, Conn.

Straightening Machinery
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Shuster Co., The F. B., New Haven, Conn.
75 sizes. 1" and smaller, various shapes.
Springfield Machine Tool Co., Springfield, Ohio. Cable: Montanus.
Bench straightening press, 3 sizes.

Slotters, Opening Stud
Errington, F. A., 39 Cortlandt St., N. Y. City.

Swaging Machines
Excelsior Needle Co., Torrington, Conn. Cable Address: Excelsior.
Sizes—Nos. 00, 1, 2, 3, 3½, tube. Capacities: $\frac{1}{16}$", $\frac{3}{32}$", $\frac{1}{8}$", $\frac{3}{16}$", $\frac{1}{4}$", 2", 1¾". 30 lb., $100; 100 lb., $200; 500 lb., $350; 850 lb., $450; 1,750 lb., $550; 2,450 lb., $600; 2,100 lb., $600.
Taper, point and reduce all kinds of solid and tubular or hollow metals.
Agents: Coventry Swagging Co., Ltd., White Friars Lane, Coventry, England; Societe Arronyme des Establissement de Fenwick Freres & Co., 8, Rue de Rocroi, Paris, France.

Switches and Switchboards
C & C Elec. & Mfg. Co.—Garwood, N. J.
General Electric Co., Schenectady, N. Y.
Gerstner & Sons, H., 22 Columbia St., Dayton, O.
Sprague Electric Works, 527 W. 34th St., N. Y. C.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Penn.

Tachometers
Bristol Co., Waterbury, Conn.

Tap Extractors, Broken
Walton Co., The, Hartford, Conn.
Sixteen sizes from No. 8 to 1¼" taps.

Tap Holders
Errington, F. A., 39 Cortlandt St., N. Y. City.
Greenfield Tap & Die Corp., Greenfield, Mass.
Warner & Swasey Co., Cleveland, Ohio.

Taper Pins
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, Ohio.

Tapes, Measuring
Starrett Co., L. S., Athol, Mass.

Tapping Machines and Attachments
American Tool Works Co., Cincinnati, Ohio.
Baker Bros., Toledo, Ohio.
Barnes Drill Co., Inc., 830 Chestnut, Rockford, Ill.
Beaman & Smith Co., Providence, R. I.
Cincinnati Bickford Tool Co., Oakley, Cincinnati, O.
Errington, F. A., 39 Cortlandt St., New York City.
Evans Stamping & Plating Co., Taunton, Mass.
Capacities up to ¼". Hand or foot operated.
Garvin Mach. Co., Spring and Varick St., N. Y. C.
Hoefer Mfg. Co., Freeport, Ill.
Wells & Son Co., F. E., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Conn. Cable: Whitney, Hartford.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Taps and Dies
Bay State Tap & Die Co., Mansfield, Mass.
Besly & Co., Chas. H., 118 N. Clinton St., Chicago, Ill.
Brubaker & Bros., W. L., Millersburg, Pa. New York, Chicago, Pittsburgh, San Francisco.
Butterfield & Co., Derby Line, Vt.
Card Mfg. Co., S. W., Mansfield, Mass. N. Y. Office: 62 Reade St. Cable: Card, Mansfield.
All sizes in V., U. S. standard, S. A. E. standard, A. S. M. E. standard, Whitworth standard, French and International standards (metric system), Lowenherz standard, B. A. standard.
Taps—Beaman & Smith, bicycle taper, bitbrace, blacksmith, combined pipe, tap and drill, flexible stay-bolt, harbor masters', jewelers', machine or nut, machine screw, machinists' hand, mud plug, patch bolt, pipe, pipe hob, pulley, small watchmakers'. Dies—Favorite, machine or solid bolt, Paragon, round, adj. pipe, round adjustable, Smith patent adjustable, spring screw threading, solid sq. pipe, die holders. Berlin store, Arthur Kayser, Mgr., Alte Jakobstrasse, 24. European Agents: Chas. Churchill & Co., London, Birmingham, Manchester and Glasgow. Markt & Co., Ltd., Paris. Ignacz Szekely, Budapest. V. Lowener, Stockholm. R. S. Stokvis & Zonen, Ltd., Roterdam, Copenhagen, Christiania. R. S. Stokvis & Fils, Brussels. Andrews & George, Yokohama, Tokyo, Osaka. J. Lambercier & Co., Geneva. C. Civita, Milano, Italy. R. D'Auglignac, Barcelona, Spain.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Cleveland Twist Drill Co., Cleveland, Ohio.
Greenfield Tap & Die Corp., Greenfield, Mass.
Hammacher, Schlemmer & Co., 13th St. and 4th Ave., New York City.
Harris Engineering Co., H. E., Bridgeport, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Murchey Mach. & Tool Co., 64 Porter St., Detroit.
Pratt & Whitney Co., Hartford, Conn.
Reed Mfg. Co., Erie, Penn.
Pipe or bolt, solid or adjustable, ⅛" to 4".
Saunders Sons, D., Yonkers, N. Y.
Standard Tool Co., Cleveland, Ohio.
Wells & Son Co., F. E., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Taps, Collapsing
Errington, F. A., 39 Cortlandt St., N. Y. City.
Geometric Tool Co., New Haven, Conn. 545 W. Washington Blvd., Chicago. Cable: Metric.
For cutting all classes of internal screw threads above ¾ in.
Modern Tool Co., 4th and French St., Erie, Penn.
Murchey Mach. & Tool Co., 64 Porter St., Detroit.

Testing Metals and Materials
Souther Engineering Corp., Hy., Hartford, Conn.

THE WALKER LINE

It Isn't Necessary to Grind in Poor Light

With a Walker Globe Tool Sharpener you simply swivel the head and the globe-shaped casing around to the best light—then clamp it and grind your tools.

The grinder head is suspended from the top of the globe-shaped casing and the grinding wheels just clear the surface of the water.

The bowl of water under the grinding wheel is convenient for dipping the tools when they become too hot for handling. It also serves as a dust catcher.

Price $50.00 complete with two wheels and countershaft ready to use.

Write for a complete set of Catalogs which describe Walker Grinders and Magnetic Chucks.

O. S. Walker Co., Successors to O. S. Walker & Co., Walker Grinder Co. **Worcester, Mass.**

WILLIAMS' "VULCAN" CALIPER GAUGES

For External, Internal and Eternal Use

Capacities 1—3″

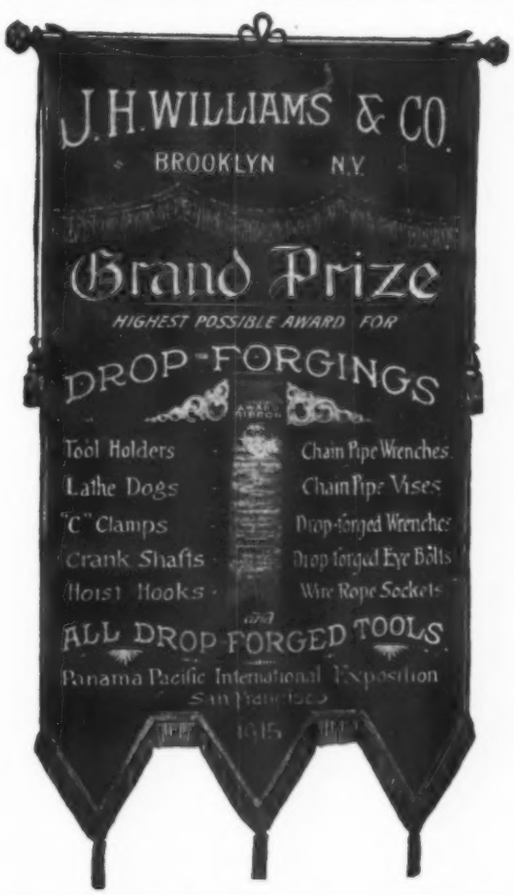
Capacities ½—3″

Capacities 3—7½″

We Forge—You Finish

J. H. WILLIAMS & CO.
35 Richards Street BROOKLYN, N.Y. CITY
The Wrench People

Western Office and Warehouse: 32 B So. Clinton Street, Chicago, Ill.



Thermometers
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Penn.

Thread-Cutting Tools
Armstrong Bros. Tool Co., 315 N. Francisco Ave., Chicago, Ill.
Geometric Tool Co., New Haven, Conn.
Greenfield Tap & Die Corp., Greenfield, Mass.
Jones & Lamson Machine Co., Springfield, Vt.
Landis Machine Co., Waynesboro, Penn.
Sizes ½" to 4".
Murchey Mach. & Tool Co., 64 Porter St., Detroit.
National Machinery Co., Tiffin, Ohio.
Pratt & Whitney Co., Hartford, Conn.
Rigid Tool Holder Co., Baltimore, Md.
Rivett Lathe & Grinder Co., Brighton, Boston,
Wiley & Russell Mfg. Co., Greenfield, Mass.
Williams Co., J. H., 35 Richards St., Brooklyn.

Tool Chests
Gerstner & Sons, H., 22 Columbia St., Dayton, O.
Twenty-eight styles carried in stock. Special cases and chests made to order.
Starrett Co., L. S., Athol, Mass.
Union Tool Chest Works, Rochester, N. Y.
Weydell, F. O., 224 S. Jefferson St., Chicago, Ill.

Tool Holders
Armstrong Bros. Tool Co., 315 N. Francisco Ave., Chicago, Ill.
Cleveland Twist Drill Co., Cleveland, Ohio.
Celfor Tool Co., Buchanan, Mich.
Pratt & Whitney Co., Hartford, Conn.
Rigid Tool Holder Co., Baltimore, Md.
Western Tool & Mfg. Co., Springfield, Ohio.
Williams Co., J. H., 35 Richards St., Brooklyn.

Tools, Small (See Machinists' Small Tools)

Torches, Blow
Gem Mfg. Co., 3257 Spruce St., Pittsburgh, Pa.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.

Transformers
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Penn.

Transmission Machinery
American Pulley Co., 29th and Bristol, Phila. Pa. 33 Greene St., N. Y. City; 124 S. Clinton St., Chicago; 165 Pearl St., Boston; 536 First Ave., S., Seattle. Cable: Amerpulley.
Caldwell Co., Inc., W. E., Louisville, Ky.
Holyoke Machine Co., Worcester, Mass.
Link-Belt Co., 39th St. and Stewart Ave., Chicago, Ill. Philadelphia and Indianapolis.
Rockwood Mfg. Co., The, Indianapolis, Ind.

Traps, Steam
American Blower Co., 1400 Russell St., Detroit.
Houghton & Co., E. F., 240 W. Somerset St., Philadelphia, Penn.
Reliance Gauge Column Co., 6009 Carnegie Ave., Cleveland, Ohio.

Trolleys and Tramways
Harrington, Son & Co., Inc., Ed., Philadelphia, Pa.

Trucks
Brown & Sharpe Mfg. Co., Providence, R. I.
Clark Co., Geo. P., Windsor Locks, Conn.
Two sizes, capacity 1,000 lb.; 4 sizes, capacity 2,200 lb. Elevating, hand and special trucks made to order.
General Electric Co., Schenectady, N. Y.
National Scale Co., Montgomery St., Chicopee Falls, Mass.
"National-Chapman" elevating trucks, 15 models, including combination scale elevating trucks. Capacities 2,500 to 4,000 lb.
New Britain Machine Co., 20 Chestnut St., New Britain, Conn. 2008 W. Grand Blvd., Detroit.

Tubing, Flexible Steel
Almond, T. R., 6 Maple Ave., Ashburnham, Mass.

Tubing, Seamless Steel
Standard Welding Co., Cleveland, Ohio.
Ward's Sons, Edgar T., 25 Purchase St., Boston.

Turntables
Link-Belt Co., 39th St. and Stewart Ave., Chicago, Ill. Philadelphia and Indianapolis.

Turret Heads
Almond, T. R., 6 Maple Ave., Ashburnham, Mass.

Turret Machines (See Lathes, Horizontal Turret)

Turrets, Tool Post
American Tool Wks. Co., Cincinnati, Ohio. Cable: Lathes, Cincinnati.
For application to any standard make of lathe.
Turret holes, rough bored to be finished by customers after turret has been mounted on lathe. Templet of lathe bed or crossbridge required.
Newman Mfg. Co., 717 Sycamore St., Cincinnati, O.
Phoenix Mfg. Co., Eau Claire, Wis.

Unions, Pipe
Dart Mfg. Co., E. M., Providence, R. I.

Universal Joints
Baush Machine Tool Co., 604 Wason Ave., Springfield, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Gray & Prior Mach. Co., Hartford, Conn.
Mutual Mach. Co., 27 Wells St., Hartford, Conn.

Valves
International Steam Pump Co., 115 Bway., N. Y.
Richardson-Phenix Co., 119 Reservoir Ave., Milwaukee, Wis.
Southwark Fdry. & Mach. Co., Philadelphia, Pa.
Watson-Stillman Co., 42 Church St., N. Y. City.

Varnishes
Felton, Sibley & Co., Inc., 136 N. 4th St., Phila.
Glidden Varnish Co., Cleveland, Ohio.
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Vise Stands
LeBlond Machine Tool Co., R. K., Cincinnati, O.
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Vises, Drilling Machine
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Graham Mfg. Co., Providence, R. I.
Horton & Son Co., E., Windsor Locks, Conn.

Vises, Metal Workers'
Athol Machine Co., Athol, Mass.
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Western Tool & Mfg. Co., Springfield, Ohio.

Vises, Pipe
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Butterfield & Co., Derby Line, Vt.
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Saunders Sons, D., Yonkers, N. Y.
Western Tool & Mfg. Co., Springfield, Ohio.
Williams & Co., J. H., 35 Richards St., Brooklyn.

Vises, Planer and Shaper
American Tool Works Co., Cincinnati, Ohio.
Cincinnati Milling Machine Co., Oakley, Cincinnati, Ohio.
Cincinnati Planer Co., Cincinnati, Ohio.
Graham Mfg. Co., Providence, R. I.
Hendey Machine Co., Torrington, Conn.
Sellew Machine Tool Co., Pawtucket, R. I.

Vises, Universal Machine
Becker Milling Machine Co., Hyde Park, Mass.
Cincinnati Milling Machine Co., Oakley, Cincinnati, Ohio.
Horton & Son Co., E., Windsor Locks, Conn.
Kempsmith Mfg. Co., Station A, Milwaukee, Wis.
Cable: Kempsmith, Milwaukee.
Skinner Chuck Co., New Britain, Conn.

Vises, Woodworkers'
Hammacher, Schlemmer & Co., 13th St., and 4th Ave., New York City.

Voltmeters
Bristol Co., Waterbury, Conn.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburgh, Penn.

Wash Stands and Bowls
Manufacturing Equipment & Engineering Co., 209 Washington St., Boston, Mass.

Washers
Kales-Haskel Co., Detroit, Mich.

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C & C Elec. & Mfg. Co., Garwood, N. J.
General Electric Co., Schenectady, N. Y.
Toledo Electric Welder Co., 4100 Langland St., Cincinnati, Ohio. Cable: Tolcin, Cincinnati.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.

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C & C Electric & Mfg. Co., Garwood, N. J.
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General Electric Co., Schenectady, N. Y.
Toledo Electric Welder Co., 4100 Langland St., Cincinnati, Ohio. Cable: Tolcin, Cincinnati.
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Linde Air Products Co., 42nd St. Bldg., N. Y. C.
Oxweld Acetylene Co., Chicago, Ill.

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Oliver Machinery Co., Grand Rapids, Mich.
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Armstrong Bros. Tool Co., 315 N. Francisco Ave., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Page-Storms Drop Forge Co., Chicopee, Mass.
Whitman & Barnes Mfg. Co., Akron, Ohio.
Williams Co., J. H., 35 Richards S., Brooklyn.

Wrenches, Machinist
Coes Wrench Co., Worcester, Mass.
Hammacher & Schlemmer Co., 13th St. and 4th Ave., New York City.
Moore Drop Forging Co., 333 Birnie Ave., Springfield, Mass.
Page-Storms Drop Forge Co., Chicopee, Mass.
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Williams Co., J. H., 35 Richards S., Brooklyn.

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Greene, Tweed & Co., 109 Duane St., N. Y. City.
Greenfield Tap & Die Corp., Greenfield, Mass.
Pratt & Whitney Co., Hartford, Conn.
Williams Co., J. H., 35 Richards St., Brooklyn.

Wrenches, Tap
Bay State Tap & Die Co., Mansfield, Mass.
Butterfield & Co., Derby Line, Vt.
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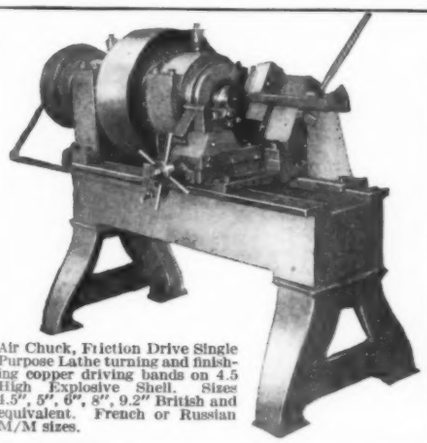

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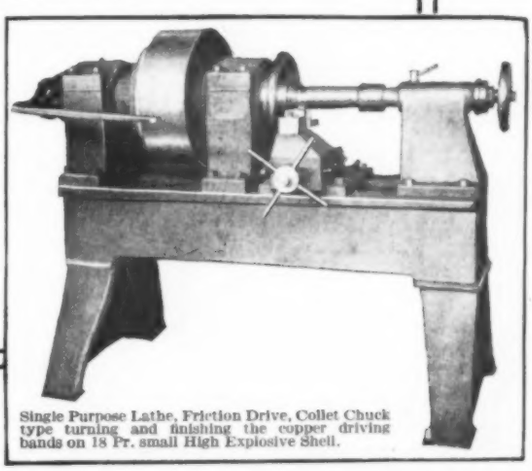

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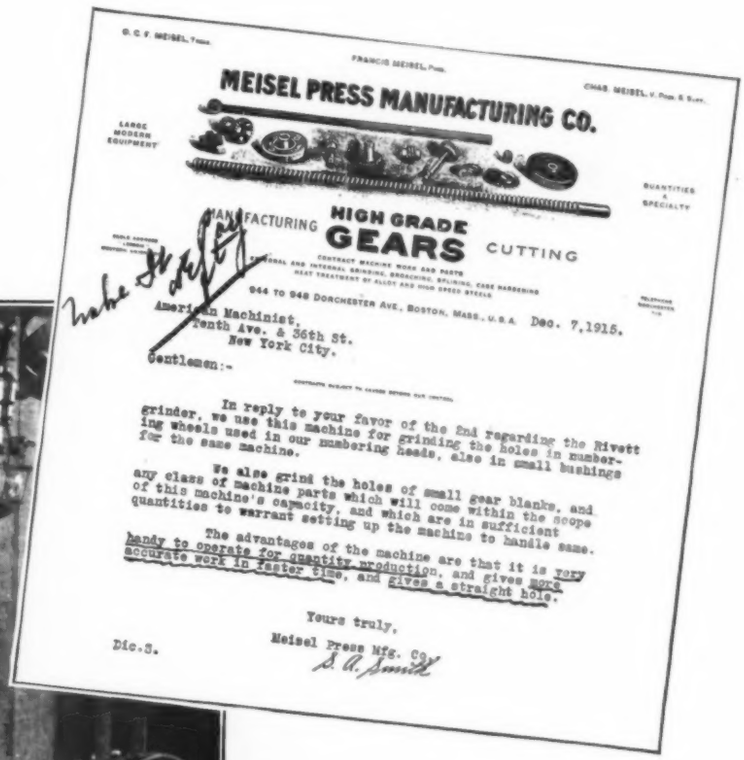

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LARGE MODERN EQUIPMENT

MANUFACTURING **HIGH GRADE GEARS** CUTTING

QUANTITIES A SPECIALTY

944 TO 948 DORCHESTER AVE., BOSTON, MASS., U.S.A.

Dec. 7,1915.

American Machinist,
Tenth Ave. & 36th St.
New York City.

Gentlemen:-

In reply to your favor of the 2nd regarding the Rivett grinder, we use this machine for grinding the holes in numbering wheels used in our numbering heads, also in small bushings for the same machine.

We also grind the holes of small gear blanks, and any class of machine parts which will come within the scope of this machine's capacity, and which are in sufficient quantities to warrant setting up the machine to handle same.

The advantages of the machine are that it is very handy to operate for quantity production, and gives more accurate work in faster time, and gives a straight hole.

Yours truly,
Meisel Press Mfg. Co.

Dic.S.

Why not write for Rivett Catalog?

from

Meisel Press Manufacturing Company

Self explanatory, is it not? One of these little messages that come from RIVETT users—when they have time to write 'em!—messages that explain just why one RIVETT machine makes a man a permanent RIVETT buyer.

Rivett Lathe & Grinder Company

Brighton, (Boston,) Mass.

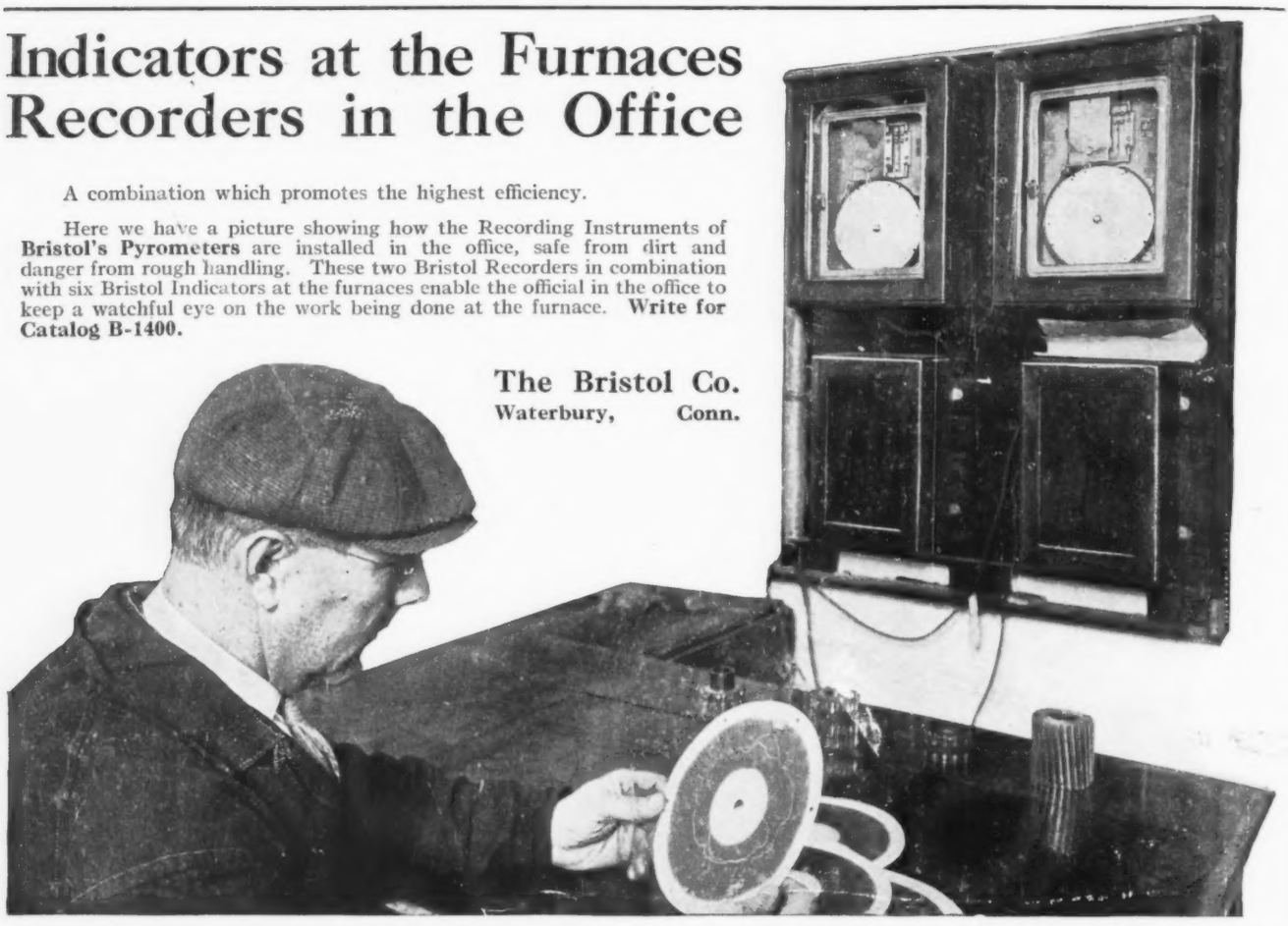
RIVETT

Indicators at the Furnaces Recorders in the Office

A combination which promotes the highest efficiency.

Here we have a picture showing how the Recording Instruments of **Bristol's Pyrometers** are installed in the office, safe from dirt and danger from rough handling. These two Bristol Recorders in combination with six Bristol Indicators at the furnaces enable the official in the office to keep a watchful eye on the work being done at the furnace. **Write for Catalog B-1400.**

The Bristol Co.
Waterbury, Conn.



Mr. J. P. Brophy

Cleveland Automatic Machine Company

Just before the New Year, we ask your attention—

On page 7 of your Catalog we find this statement staring at us in bold red letters, "The Pre-eminence of the 'Cleveland' is Indisputable."

That gives us courage to address you thus personally asking for a few minutes of your time, valuable as we know that time is.

We have a proposition that is worthy of your attention—that will help to keep the pre-eminence of the "Cleveland" indisputable.

We have a bearing bronze that lasts twice as long as phosphor bronze or any other bronze.

This has been proved during the past several years beyond all question in the automobile field. There you will find "Non-Gran" used for bearings in the majority of good cars.

Now, with "Non-Gran" we are knocking at the doors of your field, Mr. Brophy—the machine tool field. We want "Non-Gran" to win its way in the machine tool and machinery construction field just as it has won it in the automobile field—on the basis of merit.

"Non-Gran" is better because, unlike phosphor or other bronzes, it is non-granular in structure. It is fibrous and the fibres interlocking offer remarkable resistance to the pull of friction.

Used in Cleveland Automatics we claim that "Non-Gran" will have double the life possessed by the bronze bearings you are now using.

A big claim and a bold one. We ask you to put it to the test. Will you let us place our proofs before you?

You may not need this better bearing bronze just now. But you will soon. Why not investigate now?

American Bronze Company

Berwyn, Pennsylvania

"DOUBLE THE LIFE — HIGH SPEED NON-GRAN BEARING BRONZE — OF YOUR BEARINGS"